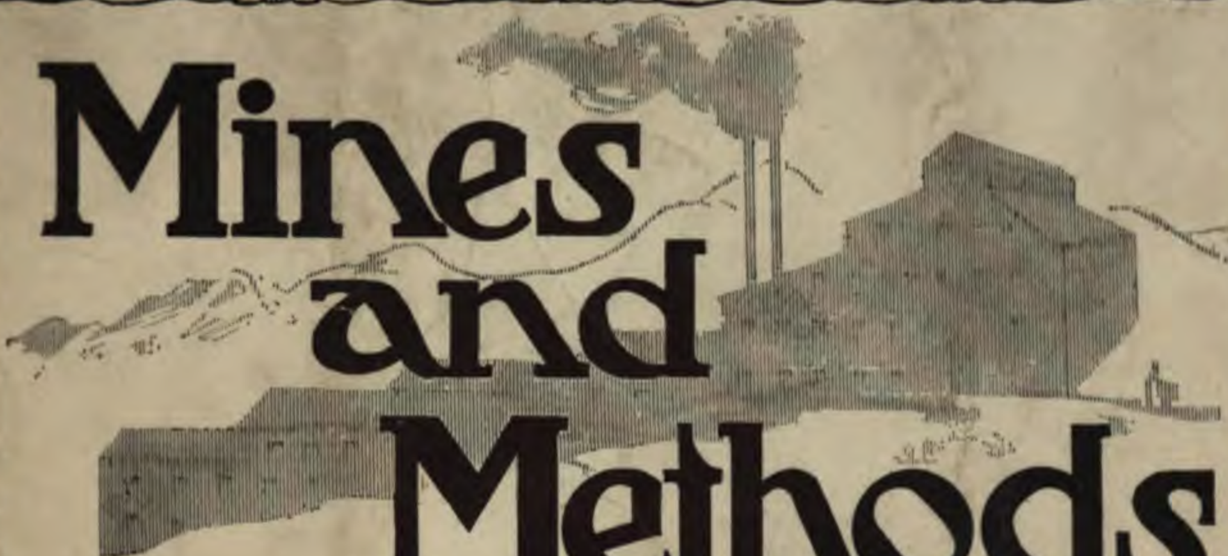
Mines and Methods



Utah Copper Servitors Assail Mines and Methods and Draw Forth a Few Pages of Pertinent Recital and Comment.

Salt Lake City, Utah
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MINES AND METHODS INDEX

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Mines and Methods

No. 1 SALT LAKE CITY, UTAH, SEPTEMBER, 1911 Every Month

Utah Copper Servitors Assail Mines and Methods

Few Pages of This Issue Are Therefore Devoted to Recital and Comment Touching Men, Events and Things Pertinent to the Occasion

Recent assaults upon the policy of this journal the personnel of its contributors and supposed ds by certain publications, coupled with ful- adoration of the management and methods e Utah Copper Company, are but manifesta- of the increased energy which is being in- d into the publicity department of that cor- ion, with the hope that by increased volume requency of the "tum-tum" of the hired pipers, ardy public may be induced to again invest me of the treasury shares of that company thus relieve the tired backs of the pooled in- ts which long since have reached the breaking t in efforts to supply the ever-increasing de- ls of the "stripping fund," consolation alone found in contemplation of augmented "de- l assets" which result from these expenditures.

The bonded and floating debt of the Utah Cop- Company now exceeds the amount of all divi- s paid to January 1, 1911, by nearly three mil- of dollars, as will clearly be shown by the wing:

It will be remembered that upon conclusion of bsorption of the property of the Boston Con- ated Mining Company, about February 1, 1910, Utah Copper Company offered for sale to its holders—exclusive of those who should be- such by exchange of shares of the Nevada olidated Company—"approximately 160,000 s of stock at $50 per share," the quoted mar- rice being then about $62 per share. Of the offering Hayden, Stone & Co.—for the "pooled sts"—underwrote 75,000 shares. Of this nt only 73,437 shares were taken, yielding ,850. The price of shares having shortly there- receded and remained below the limit ($50) l in the offering, no further sales have since reported, or could legally have been made, so that the sum stated ($3,671,850) includes all funds received or possessed by the company available under its peculiar financial practice with which to pay the cost of all mine equipment, stripping, improvement of its mills, purchase of rights-of-way, additional mining property, legal and all extraordinary expenses. At about that time the Wall Street Journal and other eastern papers reported a floating debt carried by the Utah Copper Company of about $2,100,000—and this was geneally understood to be the condition of the company's finances at the close of the year 1909.

As a consideration for "procuring" the consent of the American board of directors of the Boston Consolidated Copper & Gold Mining Company to an exchange of its shares for those of the Utah Copper Company the latter company—in addition to a bonus of 3,200 shares of stock of its company—paid to Samuel Untermyer, counsel of the Boston company, in cash $582,500, and also paid as expense of winding up the affairs of the Boston Consolidated company, the sum of $50,000. In addition to the above, the cost of taking several witnesses, newspaper men and engineers to New York for the purpose of securing suitable affidavits for use in the New Jersey courts, together with legal and other expenses incident to defense of an action brought by stockholders of the Utah company to prevent consolidation of the two companies, could not have been less than $100,000, no part of either of which sums have ever been mentioned in the Utah company's reports to its stockholders, and could only have been paid out of the money derived from the shares sold upon the underwriting of Hayden, Stone & Co., as before stated.

The cost of remodeling the Arthur and Magna mills has been officially estimated at $1,250,000, but will doubtless greatly exceed that sum. The

company's annual for 1910 reports $101.000 paid for mining property, including $30,000 paid for the Shawmut group of claims, but makes no mention of $75,000 paid for the Barnsdall-Pay Roll group, nor of 6,650 shares of Utah Copper stock subsequently given to Barnsdall in payment for ores surreptitiously taken from his property prior to its purchase. The delivery of these shares, however, did not effect the company's immediate cash resources, and is only mentioned incidentally as of possible interest to any remaining outside shareholders. In addition to the foregoing, because of its inability to dispose of any more shares in the public market, the company borrowed $2,500,000 upon an issue of 6 per cent bonds, issued in the name of the Bingham & Garfield Railroad Co., the principal and interest being guaranteed by the Utah Copper Company, which of course is the sole beneficiary, the amount being a first lien upon all of the property of the Utah company and exchangeable for its shares at $50 per share.

An inspired item in one of the company's apparently subsidized papers—the Salt Lake Evening Telegram—of September 13, instant, and repeated the following day, gives the total cost of its Bingham & Garfield railroad as "more than five millions of dollars," which sum is doubtless several hundred thousand dollars below the actual amount which will have been consumed before complete equipment of this spectacular and unnecessary undertaking.

In addition to the foregoing the cost of stripping" and removal of the overburden for the years 1910-11, together with the construction of several miles of switching tracks and the purchase of twelve or fourteen additional steam shovels, are yet to be provided for. The total cost of stripping, right-of-way and general expense for the year 1910 is stated in the anual report for the year at $1,260,-666.31, of which amount $272,674.58 was charged to "operating" account, leaving a balance of $979,-991.73 as a charge against the fund arising from the sale of shares to the Hayden, Stone & Co. "pooled interests" before referred to. The manager's report for the year 1910 states that "the total capping removed from both the Utah and Boston areas was 2,814,764 cubic yards." Therefore, by dividing the balance of $979,991.73 which remained after deducting the sum of $272,674.58 as "prepaid expense ore stripping" from the total cost of stripping, we find that the balance of the net cost of stripping per cubic yard was a little more than 30 cents.

The second quarterly report for the current year states that "there was removed from both the Utah and Boston groups a total of 1,395,504 cubic yards of capping," and that for the first quarter of 1911 957,149 cubic yards were removed, the total for the two quarters ending June 30 being 2,352,649 cubic yards which, at 39 cents per yard, gives a total net cost of $917,533.11, all of which sums aggregate a total or $9,056,024.84, exclusive of the sum of $2,100,000—floating debt—carried over into the year 1910. At the present rate of stripping the foregoing debt will on that account—at the close of the year—have been further increased by at least $1,400,000, SO THAT AT THE END OF THE YEAR 1911 THE ACCUMULATED DEBT WILL HAVE REACHED THE STUPENDOUS SUM OF $10,406,000, EXCLUSIVE OF ANY FLOATING DEBT which may have existed at the close of the year 1909.

In view of the foregoing facts it is not surprising that frantic appeals to the public should constantly arise from the quivering sheets that compose the company's publicity bureau, nor that this hungry squad should be augmented by volunteers from the impoverished field of so-called technical journalism—because, here the labor is light and compensation liberal, all "copy" being supplied from the main office.

Among the most recent recruits to the chorus of claquers is the Mining and Scientific Press, published at San Francisco, California, and controlled by T. A. Ricard—an "extinct" mining engineer—and the Mining Magazine, published at London, England, and edited by the same Mr. T. A. Ricard. The first requirement exacted of applicants seeking to enlist in the pie brigade seems to be vigorous denunciation of this journal and Col. Wall, former owner of the mining property comprising the principal holdings of the Utah Copper Company. Up to the present writing Geo. L. Walker, editor of the Boston Commercial and WALKER'S WEEKLY COPPER LETTER, occupies first place at the pie counter, he having displayed extraordinary versatility and refinement in the use of libelous expletives, as well as unctious appeals to the public to buy Utah Copper shares at any price. Ricard's opening remarks give promise that he will soon become a close second.

The following is from the pen of Mr. Ricard and appeared in his London Mining Magazine of August 11, 1911:

> Among publications furnishing useful information on mining and metallurgical progress is Mines and Methods, a monthly journal published at Salt Lake City, Utah. It is now nearly two years old and is thus our contemporary in the literal as well as the literary sense. During these two years this Western American periodical has

provided a considerable quantity of technical information, which would have inspired greater confidence if obviously it had not been used chiefly as a stone to hurl at the head of the Utah Copper Company. Even a casual glance at the pages of Mines and Methods shows that its chief purpose is to attack the personnel of the management controlling the biggest copper enterprise in Utah. This vendetta is inspired by Colonel E. A. Wall, whose Improved Ore Jigger also furnishes a subject for the principal page of advertisement. Into Colonel Wall's quarrel with the Utah Copper we shall not probe, for we have no clear notion of its underlying cause, any more than that which prompted the violence of a verbal attack, duly recorded in Mines and Methods, made by the editor, Mr. Claude T. Rice, against Mr. D. C. Jackling, the general manager of the supposedly objectionable company. In the interests of technical journalism, however, we do not hesitate to say that technology ought not to be used as a cloak for a private quarrel. Notwithstanding the obvious merit of many of Mr. Rice's writings they are unreliable for the simple reason that so many of them are prepared not so much to give interesting technical data as to serve as a catapult against the Colonel's enemy; in short, they are not trustworthy. As now conducted Mines and Methods ranks with a broker's circular.

Our readers will search in vain the pages of Mines and Methods to find any justification of the allusions to Col. Wall contained in the article above, and as to Mr. Rice: his relations to this magazine were completely terminated in the month of May, 1910—seventeen months ago—which fact was published at the time in Mines and Methods. And in fairness to Mr. Rice and this journal it may be said that during his employment as editor none of the comments upon or discussions of the Utah Copper Company's mines, management or methods, which from time to time appeared in this publication were written by Mr. Rice, excepting a certain illustrated description of the Garfield mill and an account of a certain controversy which arose between Mr. Rice and Mr. Jackling in the latter's office. Mr. Rice was in the field the greater portion of the term of his employment, visiting the mines of Arizona, Mexico, Nevada and Montana, and his work was therefore almost wholly of a technical and descriptive character, in which field he has few equals and no superior.

Before his engagement with this journal Mr. Rice for several months occupied the position of assistant editor of the Mining and Scientific Press, under the same Mr. Ricard, and it now seems probable that Mr. Ricard, in the article above quoted, has taken occasion to even up some old scores or jealousies and at the same time pave the way to the favor of the management of the Utah Copper Company.

Late developments indicate that Mr. Ricard's California journal will shortly open up for the Utah company with the publication of the result of a purported personal inspection of its properties by one of its staff who recently visited the property, and which will as well supply necessary material for Mr. Ricard's London publication, thus providing real "hot stuff" for consumption of his London constituency, who are being quietly advised to "load up" on Utah, Chino and Ray Con.

It may not be amiss at this juncture to remind our English readers that Mr. T. A. Ricard, editor of the London Mining Magazine and chief owner of the San Francisco Mining and Scientific Press, is the same T. A. Ricard—late mining engineer—upon whose report the INDEPENDENCE MINE, situated at Cripple Creek, Colorado, was bought by credulous English people who paid therefor the very comfortable sum of $10,000,000. The sequel to this transaction, as told by numerous credible persons resident of Cripple Creek at the time, is briefly as follows: It appears that upon conclusion of the sale an English gentleman was placed in charge of the business management of the property with A. Chester Beatty—brother-in-law to Mr. Ricard—as assistant; that in order to insure a permanent market for the ores at a price and upon terms satisfactory to the management, a contract was made with a prominent "ore sampling and reduction company" which provided for the sale of the product of the mine to that company for a period of four years, it being specifically provided in the contract that the PURCHASER should sample and thereby determine the value of the ore and the price per ton to be paid therefor. This method, it appears, was thought to be necessary because of the fact that frequent complaints had theretofore been made by other shippers to the effect that dishonest returns had been made by this and other sampling companies, so that it was often charged that it was impossible for small shippers to secure anything like the true value of their ores; and therefore, to avoid dissatisfaction and dispute in respect to the price to be paid for the ores of the Independence mine, it appears that the entire responsibility of DETERMINING THE VALUE AND THE PRICE TO BE PAID was—by the contract—IMPOSED UPON THE PURCHASERS.

This method—according to the evidence at hand—worked to the entire satisfaction of all parties IMMEDIATELY concerned for some three years and until the fact was noticed by some of the inquisitive English owners that the grade of the ore, as shown by the report of sales, was running very much below the estimate of Mr. Ricard, upon which the property had been purchased. In fact ores, indicated by the report of Mr. Ricard as having an average value of $200 per ton and over, were uniformly returned as of the value of only

$20 to $30 per ton. These allegations were naturally disquieting and finally led to open charges that the mine had been "salted," and of course the blame at once attached to Mr. Ricard who, without much delay, admitted that deception had been practiced upon the English purchasers but was able, it appears, to convince them that he had been imposed upon and deceived by subordinates employed by him in sampling the mine. As a result of the exposure, however, Mr. Ricard severed his connection with the property and publicly announced his retirement from the practice of mining engineering —a resolution which he has faithfully observed ever since. It appears that Mr. Ricadr's brother-in-law, Mr. Beatty—who had become disgruntled at his kinsman—reported inside conditions to John Hays Hammond, then in the service of the Venture Corporation, the purchaser, who at once proceeded to Cripple Creek, ousted the delinquent management (with the exception of Beatty), and declared void the contract upon which the ores had been disposed of—and to which the "sampling and reduction company" meekly submitted, although the contract had then still something more than a year to run.

It may be significant to note that, upon the assumption of the management of the property by Mr. Hammond, it is said that the grade of the ore simultaneously increased to a point approaching approximately the original value represented by Mr. Ricard. So that, as we are informed, our English friends have practically since recouped their supposed loss and are in a fair way to eventually reap a handsome profit. It is said, also, that the company which purchased the ores of the Independence mine, NOTWITHSTANDING THE HARSH TERMS OF THE CONTRACT BEFORE ALLUDED TO, were able—through the exercise of exceptional metallurgical skill—in the short space of three years to clean up about $6,000,000, besides gaining a knowledge of the treatment of low-grade ores which has enabled them to secure almost a monopoly of our newly-discovered "disseminated" porphyry ores. It is worthy of note in this connection that this little band of metallurgical wonders guard the secrets of their Cripple Creek success with more than brotherly solicitude, so that any member of the original group may command the support of the whole on any occasion, for any purpose or adventure; so solicitous are each of the members for the common weal and so fearful are they that in some unguarded moment these precious metallurgical secrets may be lost, that they never violate the compact under which they "stand together."

Upon his retirement from the profession in which he had acquired prominent distinction Mr. Ricard invested a portion of his savings in the purchase of the New York Engineering and Mining Journal, valued at some $500,000 and which, becoming unprofitable, or uncongenial, he sold. Subsequently he bought the San Francisco Mining and Scientific Press, but finding the duties of editing this small sheet too circumscribed, he took up his abode in London and began the publication of the Mining Magazine, the services of which have evidently been called for by his erstwhile metallurgical friends. We shall endeavor to keep our readers informed of the progress of Mr. Ricard's labors in behalf of the Utah Copper Company in its efforts to distribute its shares among our English friends.

FRIENDLY RELATIONS STRAINED

We regret to note that the friendly relations which for many years have existed between D. C. Jackling, general manager of the Utah Copper, Nevada Consolidated, Chino and Ray Consolidated companies, and Mr. George O. Bradley, mechanical and constructing engineer of the Ray Consolidated company have become strained and that, in consequence, Mr. Bradley has been—or will shortly be—relieved by the manager.

It appears that the Ray Consolidated mill—which in minutest detail was modeled after the original Copperton and Garfield mills—has failed to meet the expectations of Manager Jackling, notwithstanding the fact that the designs and plans upon which the mill was built were as ordered by him. It now appears —much to the surprise of the manager and "Metallurgist" Janney—that serious metallurgical complications have developed in the minerological structure of the Ray Con. "disseminated" ore which renders it stubbornly refractory and unyielding to the Utah Copper method of concentration and that Mr. Bradley is held to be responsible for the unsatisfactory conditions that have resulted therefrom. But we have good reasons for believing that Mr. Bradley is entirely blameless in this regard.

The facts are that the methods originally employed at the Garfield mill have been quietly undergoing changes in order to conform to the more modern and sane methods so persistently urged by Col. Wall previous to his resignation from the directorate of the Utah company and that the nature of these changes, which have proven to be the salvation of the Utah company—if there be any—have been concealed from Mr. Bradley as well as the public. So that, the Ray Con. mill now proves to have been constructed upon the plans of a discarded system, and therefore does not conform to the requirements of metallurgical advancements now in partial use at the Magna plant.

We shall watch further development with much interest, but offer the suggestion at this time that a solution of the difficulties probably lies in the adoption of some process of leaching, in which event, however—to insure any degree of success—it will be necessary to secure the services of a REAL metallurgist.

UTAH COPPER AS VIEWED BY ITS OWN SUBSIDIZED PRESS

We have devoted a considerable portion of this and previous issues of Mines and Methods to a review and discussion of the operations of the Utah Copper Company and have made frequent allusion to its method of spreading broadcast through the public press extravagant and untruthful statements regarding the condition of its affairs and the "matchless" genius and skill of its management. Because of these utterances we now find some of the most subservient pensioners of this powerful corporation engaged in the publication and distribution of slanderous inuendoes directed against this journal and its supposed friends, coupled with ridiculously false statements regarding the value of the company's mines, all of which publications are procured palpably for the purpose of promoting the sale of shares of its stock.

And now—in respect to the wishes of the manager of this corporation—having suspended the publication of all advertising matter and thus secured a few additional pages of room, (lest we be accused of bias in the character of information given to our readers), we have determined to reproduce from time to time some of the concoctions which are being doled out by the paid corps of writers which make up the company's "publicity bureau." In pursuing this course we shall make such comments with respect to the matter published as may seem pertinent, but will give our readers an opportunity to acquire a knowledge of the ESTIMATE OF VALUE TO INVESTORS that is placed upon shares of the corporation by the pooled interests. The following, which is reproduced under the regular heading of the document, is from the pen of Geo. L. Walker, editor of the Boston Commercial and Walker's Weekly Copper Letter, and is the assumed result of a critical, personal examination of the property, "written at Bingham, Utah:"

CHARLES T. DUKELOW. GEORGE L. WALKER.

CABLE ADDRESS, "WALDUKE," BOSTON.

WALKER'S COPPER LETTER (MAILED SEALED, 2c STAMP) [illegible] PER YEAR

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THE BOSTON COMMERCIAL (CONTAINING WALKER'S COPPER LETTER) [illegible] PER YEAR

BOSTON, SEPTEMBER 8, 1911.

WALKER'S WEEKLY COPPER LETTER No. 463.

Utah Copper is almost as big as all the other porphyries combined. It will mine and treat 300,000,000 tons of ore, and possibly 500,000,000, before its property is exhausted. Should its management continue to develop new methods of economical handling and treatment, as it is doing now, it will be sending 1 per cent ores to the mill 25 or 30 years hence and still be making copper at a cost of seven or eight cents a pound.

Three or four years ago Utah Copper's concentrator was making an average recovery of 64 to 66 per cent of the value in the ore. The four sections of its Arthur mill, which have been remodeled, are now recovering 75 to 76 per cent of the values from a lower and therefore more difficult grade of ore to concentrate.

No effort is being made to mine a high average grade of ore at present. Two of its steam shovels are loading cars now from one of the lowest grade areas in the property. These areas could easily be avoided and ore that will average nearly 2 per cent supplied to the concentrator; but Utah Copper is being operated on business principles, as a permanent and not as a temporary enterprise.

There is a belt of ore extending through the center of Utah Copper's big deposit for a distance of nearly a mile, which will average almost 2 per cent copper. It is about 850 feet wide, and the deepest drill holes and other openings in it, 700 or 800 feet below the surface, were stopped in 1½ per cent ore. There is more than a possibility that this area alone will contain, when fully developed, as much ore as the management estimated in last year's report, 220,000,000 tons.

It will take Utah Copper between 50 and 100 years to exhaust its ore resources, even after it attains to a daily output of 20,000 tons. Meanwhile its operating costs will be gradually reduced and its savings, or recovery of values, increased. Undoubtedly there is at least 6,000,000,000 pounds of recoverable copper in its ore body. A profit of five cents a pound on this amount will mean an ultimate return of $300,000 000 to stockholders.

Taken as a whole, the Utah Copper company's ore area is about a mile long and a half a mile wide. Prospecting and development to date indicate that the ore averages considerably over 300 feet in thickness. As a matter of fact, however, the full depth of the ore has not been determined. Accidents stopped several drill holes when they were still in 1½ to 2 per cent ore, and no tonnage has ever been calculated below such openings by the management, except where underground openings have gone deeper. Years ago some diamond drills were stopped when they got down into the 1½ per cent horizon, as in those days even this was not considered ore at all. With the company's present facilities for handling, and its low concentrating costs, this is now good ore.

Considered in a general way the Utah Copper ore body is richer in the upper 200 feet and gradually declines in value with greater depth, and also toward the outer rims. During the first 40 or 50 years of its

operations the company will mine and treat ore averaging between 1.55 and 1.75 per cent copper; and in the remaining 35 or 40 years of its career it will work on ore running from 1.15 to 1.45 per cent. There is every prospect, however, that operating costs per ton will be reduced and the percentage of values recovered will increase more rapidly than the grade of the ore will decline. With copper selling at 12½ cents, therefore, the profit realized on a ton of 1.25 per cent ore will probably be greater 40 years hence than it is on 1.60 per cent ore now.

As has been explained previously, the Utah Copper company is laboring under many disadvantages at present which will be overcome and eliminated one after another. The area from which it gets its steam shovel ore is so small that blasting and the switching of trains cause frequent delays and loss of time. When five or six times as much ore has been completely stripped, and this will be accomplished within a year, elimination of delays will reduce the cost of steam shovel mining at least 10 per cent; and there will be a further reduction in costs due to the decrease in the percentage of all the ore extracted that is mined underground.

Through the operation of its own railroad the cost of getting a ton of ore from the mine to the mill will probably be reduced 17 cents, equivalent to three-quarters of a cent per pound of copper produced. The railroad is completed from the mine to the Magna plant, 17½ miles as compared with 27 miles by the road now used. It is a magnificent line, having several tunnels, big steel bridges, a splendidly ballasted roadbed, few curves, 90-pound rails, commodious terminals and a maximum 2½ per cent grade in favor of the load from the mine down to the mill. The beginning of operations is being delayed by the difficulty the trunk lines are experiencing in transporting the immense locomotives, the largest ever built, from the shops in the East to Salt Lake City.

About 2,200 men are employed at the Utah Copper mine, and approximately 50,000 tons of capping and ore is being moved daily, or 23 tons per man. Of this amount 13,000 tons is ore and 37,000 tons is stripping. It will thus be seen that the company is working for the future more than the present, as there are three and a third times as many tons of ore in the property as there are of stripping to be removed. The thickness of the capping is so great and its position such, on the side of a steep mountain, that it cannot be removed acre by acre as the ore is needed; but it must be stripped over a very wide area and benched back to make room for many steam shovels, and to overcome the possibility of caving such as would tend to mix the capping with the ore.

The engineers' figures indicate that 37,500,000 cubic yards of stripping will have to be removed to uncover the ore body fully and provide necessary stopes along the rims to permit of its complete extraction. Of this amount 29,000,000 cubic yards lies on the ore and 8,500,000 in the slope areas.

So far 9,385,000 cubic yards of stripping, or between 25 and 30 per cent of the whole, has been removed, equivalent to uncovering over 60 000,000 tons of ore. Only 13,500,000 tons of this ore has been excavated and treated. This means that about five times as much ore has been stripped as mined. So far this year 15,000,000 tons has been uncovered and only 2,500,000 mined, a ratio of six to one. This great amount of advance stripping is being done to prepare for a larger daily production and consequent lower costs.

The prediction that Utah Copper will be able to produce its copper at a gross cost of six and a half to seven cents a pound after another year of stripping and preparatory work are based upon actual deductions conservatively made from results now being accomplished. These figures are arrived at by subtracting the savings to be effected by operating its own railroad, running its concentrators at full capacity, the higher average recovery of values throughout that has been demonstrated on four sections of the Arthur mill, a more advantageous utilization of labor at the mine through the elimination of delays and the reduction of smelting penalties by classifying and cleaning the concentrates. Acareful summary of these several items indicates a coming reduction of more than a cent and a half per pound in the company's cost of making copper.

Reference has been made in the foregoing to underground mining. About 3,000 tons of ore is being taken out of the Boston Consolidated ground daily. It is mined in an area that will be stripped and steam shoveled later on, and sufficient broken ore is left in the stopes, therefore, to prevent the capping from caving. The pillars, also, are left intact. About 330 men are employed underground, the ratio of extraction being eight tons daily per man for all miners and surface men in this department.

Some time ago I wrote an extended article on Utah Copper in which I reviewed its financial operations from the beginning and presented figures to prove that the company has paid all its underground development and stripping expense, and its dividends, also, out of net earnings. The article was written for those who want reliable information; it was criticized by those who don't.

One critic declared there was nothing at the mine to account for the $809,251 expended on plant at the mine, including shops, dwellings, etc., but a machine shop and a few other unimportant buildings. Statements of this character are so misleading that it is difficult to credit one making them with honest intentions. When I was at the mine I saw 22 steam shovels, 400 ore cars and 45 locomotives, the first cost of which must have been $1,000,000, and beside churn and air drills, compressors and the other equipment. I assume, also, that the cost of its water works and teams went into the construction account. All these things cost a lot of money, and they are not accounted for in any of the other items presented.

In every mining district where big porphyry mines are being developed I find a number of nice old gentlemen who do not believe these companies will ever make a dollar of profit. These men are pioneer miners who have spent the best portion of their lives hunting for high grade ore, rich enough to mine with elbow grease and send to market on the back of a mule. They were brought up to believe that low grade ore was worthless, and it takes more than a lot of churn drills, steam shovels and big concentrators to convince them to the contrary. Having been educated to small things, they are unable to grasp and comprehend the enterprises of great magnitude that are being worked out by younger men.

These old gentlemen are entirely harmless, except when they use the money they receive for proper-

ties they themselves could not operate, to publish newspapers or magazines for the dissemination of their circumscribed ideas. When they do this some of their few readers take them seriously for a time; but sooner or later even these learn to distinguish between disinterested information and spleen.

The Utah Copper company's property is no longer a prospect, and its methods of operating are far and away beyond the experimental stage. It owns the largest demonstrated body of copper ore in the world and the biggest and best concentrators. As yet it is in the development stage and its tremendous possibilities are only beginning to be realized. Eventually it will produce over 150,000,000 pounds of copper annually—200,000,000 pounds including its proportion of Nevada Consolidated's output—and earn $7 a share on a 13 cent metal market, and $9 when copper sells at 15 cents. Its stock is one of the cheapest and safest mining investments in the world.

Readers will note that the opening paragraph declares that "the Utah company will mine and treat 300,000,000 tons of ore and probably 500,000,000 tons." The last annual report issued by the company places the amount of ore at 203,000,000, which was a jump of about 1,000,000 tons over the amount reported at the close of the previous year and in that case—like Walker—no previous announcement had been made of any new development or of work having been done which tended toward new discoveries. The closing words of this interesting narration are: "Its stock is one of the cheapest and safest mining investments in the world."

When we come to consider that Mr. Walker's writings during the last few years have enabled him to accumulate several millions of dollars one can form some idea of the value or cost of the foregoing to the Utah company; but perhaps a more correct conclusion in respect thereto may be found from the following, which is related by a newspaper man of this city: It appears that during Mr. Walker's last annual swing around the circle of Western contributing mines he prepared and published a highly complimentary description of the property of the Mason Valley Copper company's mines at Yerington, Nevada. This happened at a time when that company was offering for sale an issue of bonds for the purpose of securing funds with which to equip their property with a smelter. In recognition of the aid rendered by Mr. Walker, it was said that the company promptly sent him a check for $1,500, which he as promptly returned with the remark that the write-up was worth to the Mason Valley company $5,000. Whether that amount was paid or not our informant was not advised, but we note that Mr. Walker's report on Mason Valley for this year is even more favorable than the last, and therefore it may be inferred the estimated value of the precious send-off was paid.

No Advertising In This Issue

Our patrons will observe that this issue of Mines and Methods appears without any advertising patronage. It has never had much and freely surrenders the little it has had. This policy will be continued in the future until such time as the shadow of the displeasure of the manager of the Utah Copper Company shall cease to bar the exercise of business judgment and independence on the part of our citizens who would otherwise gladly avail themselves of the wide circulation of this journal as a means of promoting legitimate business and industrial enterprise. In so far as the gain or loss of immediate profit is concerned, it is a matter of no concern to the publishers whether they are favored with advertising patronage or not, although we admit that a publication of the character we have sought to make of this journal must labor under pronounced disadvantage unless it can have moral and financial support of the tradespeople of the community it seeks to serve. And we confess to exceeding humiliation that a whole cityfull of intelligent, enterprising, industrious and thriving American citizens, should be so overawed by the power and will of a great corporation that they must, perforce, forego the privilege of displaying their wares in the marketplace lest they give offense. We feel grateful to certain of our patrons who had the courage to refuse to withdraw their advertisements upon the demand of the manager of the corporation mentioned, but we have determined to relieve them of further embarrassment in that regard by adopting the course before indicated.

We publish below a letter received from Mr. D. E. Burley, general passenger agent of the Oregon Short Line Railroad Company, whose advertisement was dropped in accordance therewith from our July number. Insertion of the advertisement referred to in Mr. Burley's letter was not sought by us, but was soliciated by Mr. D. S. Spencer, assistant general passenger agent of the same company, and therefore the language in which the request for withdrawal is expressed by Mr. Burley is exceedingly disingenious and unfair; but perhaps it should be excused on the ground that Mr. Burley—as we are informed—has profited greatly by investment in the shares of Utah and other mining corporations promoted by the people who control the affairs of the Utah Copper Company and was therefore desirous of manifesting his gratitude and subserviency in fitting terms. Following is a copy of the letter referred to:

Salt Lake City, Utah, June 29, 1911.

Mines and Methods Publishing Co.,
306 Tribune Building, City.

Gentlemen:

I note in a recent issue of "Mines and Methods" that you are carrying our display advertisement. As we have arranged no contract during the present year and as the copy you are carrying is obsolete, I shall be obliged if you will kindly have it discontinued.

(Signed) Yours truly,
D. E. BURLEY.

Other patrons have frankly stated that they had been warned by the manager of the Utah company that unless they ceased advertising in this magazine all trade patronage of that company would be withdrawan and therefore, as before indicated, we think it due to our friends that they be left free to struggle for a share of the crumbs that may be allowed to descend to those who are fortunate enough to secure the favor of this corporation.

Our offense consists in having questioned the engineering ability and practical experience of the management of the Utah Copper Company and the integrity of the reports of its officers to its shareholders. Every charge of incompetency or lack of candor which we have preferred has been completely verified and, as a result, many stupid blunders resulting from lack of knowledge and experience in conducting operations which by chance had fallen into

their hands, have been materially improved; but the crowning absurdity in engineering mimicry still goes on with ever-increasing vigor. Twenty-four steam shovels are now required to provide the daily supply of ore for the mills, where less than half that number were needed two years ago to secure an equal quantity. And all these are supplemented by several hundred underground miners who supply nearly double the quantity of ore that was obtained from that source two years ago, at which time stockholders were assured that by the close of the year 1909 all underground mining would practically cease.

We have shown repeatedly—and the fact is apparent to every disinterested engineer who has visted the premises—that profitable extraction of this ore by means of steam shovels (because of insuperable barriers) is a physical impossibility. And we now again assert that a fair charge of all costs incident to the installation and operation of these machines, against the metal produced, would overbalance by more than $3,000,000 every dollar of assumed profit derived from the entire product of the mines from the commencement of operations to this date, and that this disparity of cost will continue and increase as long as this method is pursued.

Although we have frequently shown that the grade and quantity of ore available for extraction or known to exist in the property has at all times been grossly exaggerated and misrepresented by the trusted officers of the company in their reports to the stockholders and the public, we have consistently maintained that the property contains practically unlimited quantities of ore which—with intelligent methods—could be mined and treated at a very large profit; that, with the exception of the soil and stream gravel which occurs in depressions and flat portions of the surface, the so-called "capping," which has been removed to the extent of probably 15,000,000 tons would—if subjected to methods of crushing and concentration in use in any modern, first-class mill in Utah, Idaho, Montana or the Lake region—have yielded more profit per ton than is claimed to have been derived from the selected ores treated at the mills of the Utah company. And we have maintained, and challenge contradiction by any capable engineer, that all of the ores heretofore mined by steam shovel, and all so-called capping heretofore removed, and all known ores and capping remaining on the westerly side of the canyon stream, could have been, or can now be, mined and delivered into railroad cars at less than 10c. per ton by the very simple method known in miners' parlance as the "milling" or "gloryhole" system, such as is frequently applied to the extraction of iron ores in certain favored localities and as employed in modified form in the Treadwell mine, at Juneau, Alaska. In that instance, however, the rock is extremely hard and tough and costs are therefore comparatively high, yet infinitely lower than the cost which results from the operation of steam shovels upon the precipitous mountains of Bingham.

We have also characterized the construction of the Bingham & Garfield railroad as a reckless dissipation of the company's resources, absolutely unnecessary and indefensible from any view other than that it was expected to stimulate traffic in the shares held by the pooled interests. A few brief facts will demonstrate the correctness of our position: The assumed necessity for the construction of this road was predicated upon the pretense that the Rio Grande Western Railroad company had failed and was physically unable to transport the amount of ore required daily for the operation of their mills at their then existing capacity and that, therefore, that company could not possibly provide transportation for the increased tonnage of 16,000 to 20,000 tons which would be required to supply the mills when their capacity should be increased to that amount. At the same time we showed the fact to be that the R. G. W. Railroad company had frequently transported and delivered at the Utah company's mills more than 20,000 per day, and on certain occasions as much as 24,000 tons in one day, and that at all times, except in case of accidents or severe snow-storms, they had hauled all ore required as rapidly as the cars were filled and placed upon the receiving tracks.

During the progress of construction of the Garfield mill, when complaints against the railroad company were most persistent, we showed from actual figures that for a period of several months the railroad had actually delivered at the company's mills more than 1000 tons of ore a day IN EXCESS of the RATED CAPACITY of the completed portion of their mills—and nearly 2000 tons a day in excess of the amount claimed by the officers of the company as being treated at their mills.

But it was claimed that the rate charged per ton was high, and that a great saving would be made for the shareholder by transporting the ore themselves over their own road. This claim is wholly untenable, as we shall show: The contract with the R. G. W. R. R. Co. was for 6000 tons a day for a period of twenty years ending in 1926, and the rate for the first five years was 27½c. per ton, and thereafter 25c. per ton so that, from the close of this fiscal year, the rate will be only 25c. per ton.

A local official organ of the Utah company reports the estimated cost of transportation over the new Bingham & Garfield road at 17c. per ton. This compares with like cost of transportation by the Anaconda Mining Company, at Butte, over about the same distance but much easier grades and practically free from short curves. We predict, however, that costs on the Utah line will exceed 20c. per ton, owing to the many "switch-backs" and sharp curves to be encountered in getting down from the high mountain, where the ore will be loaded, to the main line, which itself is a succession of sharp curves and dangerous grades, as was forcibly suggested by the fact that one of the first trains consisting of some twenty odd R. G. W. cars jumped the track and as a result are now in the repair shops.

Assuming a cost of 17c. per ton over the new road, there would be an apparent gain of 8c. per ton as compared to the price paid the R. G. W. R. R. Co. A similar contract was entered into with the Boston Con. company about the same time for the same daily tonnage—6000 tons. This leaves only 8000 tons a day available to be handled by the new B. & G. R. R., provided the milling capacity be increased to the indicated amount. Working every day in the year the new road could haul only 2,920,000 tons of ore per year which, at 8c. per ton, would yield an apparent profit of $233,600. The cost of the Bingham & Garfield road is now conceded to be in excess of $5,000,000, of which amount $2,500,000 is represented by an issue of 6% interest-bearing bonds. The remaining sum cannot bear less interest. Therefore, $5,000,000 at 6% will produce an annual interest charge of $300,000, which sum exceeds the highest possible profit to be derived from the operation of the new road by $66,400. It has been erroneously claimed that the contract of the R. G. W. R. R. Co. with the Boston company is void and cannot be enforced. If this were true the new road would then have possible for transportation per year 5,110,000 tons of ore, upon which an apparent profit of 8c. per ton would yield $408,800 per annum, being $108,800 per annum in excess of the interest on the cost of its road. At this rate the investment would be returned IN A LITTLE MORE THAN FORTY-NINE YEARS providing, of course, that the supply of ore continued and that no time was lost and also that the mills and the road should not wear out. But unless this "marvelous structure" should

be exceptionally favored its entire equipment would have to be renewed every ten years, or five times during the period of forty-nine years required to recoup its original cost—all of which facts simply serve to emphasize the glaring absurdity of the whole stupid business.

In a previous issue we predicted that on completion of the Bingham & Garfield railroad it would, of necessity, be turned over to the Denver & Rio Grande Railroad Company and would thereafter be operated by that company under some form of lease which would relieve the Utah-B. & G. R. R. Company of much embarrassment and enable its officers to proclaim to the public that a rate for transportation of its ores had been secured that was even more favorable to the Utah company than would result from operating its own line—as happened in the case of the collapse of the Ray smelter fiasco, wherein it was proclaimed that a favorable rate for smelting the ore had been secured from the Guggenheims, who succeeded to the ownership of that wreck.

Our predictions have already been confirmed in the fact that a junction of the track of the supposed hostile lines has been effected and the R. G. W. R. R. Co. is now engaged in hauling Utah ores to the mills over the new Bingham & Garfield Railroad Company's lines.

MAKING MINING LEGITIMATE

Every man with a prospect to sell and every person who contemplates the purchase of mining property, or investment in new mining propositions, should read the following comment of Oscar Lachmund, taken from the Mining and Engineering World of the 16th, on "Investigation of Mining Properties:"

The condition confronting the field engineer today in his quest for desirable mining property, is usually one of high prices and unreasonable terms. In addition to this, the value of the ore and the tonnage as set forth in preliminary reports and statements, are generally overestimated, not to say purposely exaggerated. A prominent mining engineer, in speaking of conditions as at present existing in the camp of Porcupine, facetiously states that mere prospects are held at $50,000 each, and that for each speck of visible gold an additional "$50,000 per speck" is asked.

On the other hand, a certain mine in Oregon is said to have changed owners recently, and under the terms of the sale the buyers, after making the initial payment, are permitted to extract from the mine, ore of sufficient value to reimburse themselves, before another payment becomes due, and so on, until the mine is paid for. These are ideal conditions for the purchaser and are not often encountered in mining deals. Within the limits of these two extremes, many meritorious properties are found, which could easily be sold to the advantage of all interested parties, but the prices and terms are usually such that the owners will hold them a long time, unless they change their views.

A developed property with a measurable tonnage of positive ore demonstrated, may command a reasonable "cash down" payment, but the owner of the prospect must realize that, in order to get his property developed at somebody else's expense, he must allow the greater portion, if not all of the purchase price, to come out of the ground, and not out of the pocket of the purchaser.

It is apropos right here, to mention the proverbial "sucker crop;" but, fortunately, this is growing smaller each year, due to the active campaign against "wild cats," which is being carried on by the reputable mining press.

The average owner of mining property expects the prospective purchaser to take a "long chance" and assume the burden of proving up his property for him. The most equitable way is to allow him to take it over on a lease with a bond to purchase at the end of a given time, say from 2 to 5 years, with reasonable payments at long intervals. Unless an appreciable amount of shipping ore is "in sight," no cash payment "down" should be exacted. Development should be allowed to proceed until a reasonable time has elapsed, when the first payment might be made. This should be as small as consistent with the showing on the property when operations began, and the subsequent installments could be increased gradually until the entire amount of the bond had been taken up, within the life of the lease.

In the case of a developed property, the positive and probable ore reserves should show the return of the purchase price of the mine; the cost of plant installation necessary to place the property on a producing basis; the cost of extracting and beneficiating the ore, and a reasonable rate of interest on all of this capital, while the ore reserves are being extracted. If the property had met all of these requirements, it would simply be a case of "swapping dollars"; it must do more than this in order to be classed as an investment. It should earn at least 15% to 20% per annum during the entire period of production to be an attractive proposition.

This may seem unreasonable to the average prospector and claim owner, or, to owners of developed mines, but when one takes into consideration that the business man requires that a new business shall show a return of the capital invested, plus the usual interest on this money while it is being earned, plus a reasonable margin of profit each year while he remains in this business, it brings mining down to legitimate business principles, and this is where it rightly belongs.

Many complaints are heard about the difficulty of inducing capitalists to invest in mining schemes; that the times are not as they used to be, when it was only necessary to state what was "in sight," when money would be forthcoming at once, etc. Times have changed. The capitalist has been "stung" too often. He is beginning to employ technical help to advise him in his mining ventures. There is plenty of money seeking investment in the legitimate mining propositions today.

There is always a reason for wishing to sell mining property, and if the reports are flattering and the price and terms seem reasonable, there is generally a "nigger in the wood pile." This is the problem the field engineer is called upon to solve. On the other hand, if it is a large low-grade proposition needing an expensive equipment before profitable production could be expected, the reason for wanting to sell would be apparent, especially if the owner was financially unable to buy the necessary machinery.

As a rule, the preliminary report or owner's statement offered the engineer for consideration, is favorable to the property in question, and usually contains such glowing accounts of its merits that the first thing that comes to mind is the question, "What's the matter with it?" There is nothing to do but go and look at it, or run the risk of overlooking the "one chance in a thousand" of finding a real mine. But, if all these numerous propositions were to be visited, a large fortune would be required to defray traveling and other expenses, to say nothing of the engineer's time.

It is becoming the rule to insist on the seller's guaranteeing his statements and reports, by agreeing to reimburse the engineer for any expense he may be put to should he be unable to check the reports within reason. A better way would be to offer to pay the engineer's traveling expenses in advance, these to be returned by him in the event the reports were confirmed. As against this, the engineer should be able to satisfy the seller, by references or otherwise, that he is competent to make a correct mine examination.

Send a copy of this issue to some distant friend.

Mines and Methods

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CONTENTS:

TWO KINDS OF WORKMEN

The Engineering and Mining Journal very pointedly observes: "There are two kinds of workmen. One works only to get in his time; the other works to do a good job and has joy in doing it. One drops his hammer at the first pull on the whistle cord: the other finishes driving the nail, and more, if necessary. One works to do somebody: the other to do something. The second kind of workman does not have to strike for increase in pay. That matter takes care of itself, and the man is apt to become a foreman and otherwise rise in the world. The other kind is fired when business is slack and then loafs around with a grievance."

Owing to delay in receiving copy through the mails, we have been compelled to hold Mr. W. L. Austin's article on "Leaching of Copper Ore" over till next month.

MONOPOLIES OF CAPITAL AND MONOPOLIES OF LABOR

By W. L. AUSTIN.

"The Standard Oil Company is no more. Its disoecta membra are scattered over a continent. Each of the thirty octopean tentacles is now a separate entity. The great central trust is 'busted' into thirty smaller trusts. There are thirty boards of directors instead of one board, and thirty presidents instead of one president. Each stockholder in the Standard Oil Company will have an equal number of shares in each of the thirty companies. The thirty companies will not be apt to compete with each other as at present constituted, for there is no instance on record of a man competing with himself. The question now arises, where does the public come in? Will coal oil or gasoline be any cheaper?

Where does the public come in? Well, for one thing there will be more men employed by the thirty separate trusts than found occupation under one gigantic corporation. More clerks, more artisans, and more laborers, for it will be necessary to keep up at least the semblance of conducting thirty separate businesses. More money will be distributed among the working class and less will go to those whose disregard for the laws of the land has enabled them to amass more than that to which they are rightfully entitled, for it has been decided by the Supreme Court of the United States that the Standard Oil Company was an unlawful combination. The prices of the articles manufactured and sold may not be reduced; but the profits that formerly went to the particular trusts which have been ordered to resolve themselves into their component parts, will be less, and much of the cash that found its way into the pockets of the few will now go into more general circulation, because it will not be practical for pre-existing "economies" to be exploited to the same extent as has been done.

It would be well, (now that a way has been found to de-organize monopolies), if the good work were carried forward until the power to work evil, of gigantic business combinations of whatever nature, corporate and incorporate, is given its quietus. If all the trusts in the country were compelled to disintegrate into the units out of which they were formed, it is manifest that many more opportunities would be available for those who are at the present time relegated to idleness on account of being deprived of their former occupations, through contractions (economies) enforced by the aforesaid trusts.

The railroads are complaining that business is light and that therefore retrenchment is necessary. Naturally, what else is to be expected? Men are being laid off at the iron mills and factories of all kinds: everywhere the ranks of the unemployed are being augmented, those of the workers decreased. As the number of spenders is reduced, the seriousness of the situation is aggravated. The American people are extravagant as a rule; but how can men spend money when they are not permitted to earn it? A mill-hand when thrown out of employment through stagnation in the iron trade, (due to lessened demand for the product of his handiwork because others who need it have not the means to pay for it, owing to similar stagnation in their particular lines of business for like reasons), cannot at once turn his hand to farming, nor can a miner start in growing cotton when the property with which he is connected closes down. Each individual has his trade, and when some huge combination is made, and economies are started which deprive him of ability to earn a livelihood at the occupation in which experience has made him proficient, he is usually placed in sore straits. The West to which, when undeveloped, any man could go and find something to do, no longer affords the same opportunities. Times have changed and enforced idleness exists there as elsewhere, for great combinations have stifled individual effort to a great extent there also.

One point appears to have been overlooked by those who advocate trusts, which is, that to make business, opportunity to earn a living must be extended to the mass of the people of a country, and not be confined to a select few: that the buying capacity of the many is at least as essential to general business prosperity, as is the ability to produce cheaply through combination and contraction. Artificially sustained monopolistic production, combined with exorbitant prices, is fatal to the prosperity of the country as a whole—when a large percentage of the spenders have to practice close economy. This patent fact is evident to such as possess the faculty of foreseeing coming events, and accounts in a great measure for declining values on the stock exchanges. Reducing expenses by throwing men out of employment is likely to be followed by reduction or suspension of dividends on the part of the great corporations, in order that they may be in a position to meet necessary operating expenses later.

We are told that the great combinations of capital, and those formed by a

portion of the working men, the so-called trusts and the modern labor unions, have come to stay; that the country during the past two decades has undergone an economic revolution and that the result might as well be accepted as an accomplished fact. This may or may not be so: it is too soon to jump to conclusions. Where in the past whole communities have been affected by any kind of a revolution, often a considerable period has elapsed before popular sentiment became clearly established. In these days of rapid communication events transpire more quickly, but still consume time; the great public is not organized, but public sentiment when it finally reaches expression will be the deciding factor in the monopoly question as in all others.

It is true that during recent years there has been a great change in economic conditions in this and other lands, but the world-wide unrest which has thereby been occasioned warrants the entertainment of a reasonable doubt as to whether the existing state of affairs will be permitted to endure. Whether the masses will acquiesce in the retention on the part of those who have the grabbing faculty highly developed, of all that they have been able to gather unto themselves. In any event, conditions which have brought about the elimination of a large part of the spenders will require adjustment before the railroads and other industries are able to resume business on the old basis.

One of the principal claims made for "big business" is the economy effected through elimination. It is said that whereas previous to the formation of a given industrial combination there may have existed some thirty separate institutions, through centralization and elimination the same work can be carried on more advantageously by one organization. A necessary corrollary to this proposition is that some of the erstwhile separate institutions are either closed altogether or are operated with reduced forces. A few such combinations would probably not be seriously felt in a large country such as the United States; but when it comes to making combinations in every line of trade and business occupation, the number of families thereby thrown into the discard becomes a matter of very great importance even to the trusts themselves—it means enforced idleness and attendant suffering on a very large scale, with corresponding decrease in business.

Nor are salaried employees alone affected by these combinations with monopolistic tendencies, for the result of combination of industries in fewer hands is that many who previously had occupation for their capital find themselves debarred from engaging on their own account in lines of business with which they are familiar. Who, for instance, no matter how well posted in the copper business, would at the present time venture his capital in the development or exploitation of a moderate sized copper prospect? All mines were at first prospects, and the mining business has reached its present importance through the efforts of individuals in the face of discouragements which trusts do not care to encounter. The development of new mines in the United States has almost ceased as an industry because of the trusts; for even when such ventures turn out well, how is an individual to compete with large established monopolies which have the financial strength to continue producing enormous quantities of metal, if necessary at a financial loss for the time being—a financial loss, when all the factors which enter into the cost of production are taken into account, as is customary in ordinary commercial transactions.

The aim of the great combinations of labor is the same as that of the capitalistic trusts—the elimination of competition, and curtailment in the number employed. These combinations are particularly menacing towards the body politic because they are irresponsible. They are not incorporated and therefore cannot be held financially accountable for their acts. They are great powers for good or evil, and when led by unscrupulous men, are capable of inflicting great wrongs on the public, as was recently demonstrated in England. The natural desire of every good workman to excel at his craft is done away with by the principle of the closed shop, and through this agency inefficiency is tolerated and the number employed is lessened. With both classes of monopolies the final outcome of the principles advocated is the same, decrease in the opportunities of the many who seek to earn a livelihood—the elimination of the spender and consequent decrease in the volume of business.

It must be evident to every thinking person that at the present time there is something radically wrong with our economic system. There is abundance of capital in the country awaiting profitable employment, and men generally are willing enough to apply themselves at their respective callings; but still the wheels of industry lag. Various reasons have been advanced to account for existing conditions, all of which probably have some bearing upon the subject; but the fact of the matter is that paramount among the causes of trouble are the combinations in restraint of trade which have shut the door of opportunity to all but a favored few, and that the mass of the people has been unwillingly forced into making economies on its own account, because of inability to find profitable employment for its capital, or in the respective callings of its individuals. Nowadays whichever way a man turns he is confronted by monopoly in some form, which bids him move on to other fields. If he is young and hopeful he will be kept moving; if he is advanced in years, he is apt to become dependent upon the efforts of others, who may perhaps have all they can do to sustain themselves and families in the struggle.

In addition to considering ways and means for deserving the artificial conditions which have assisted in building up the great monopolistic combinations, it would be well to reflect on what is to be done with the large number of people thrown out of employment by the very economies effected by these combinations which are being extolled. Geologists tel us that in Tertiary times creatures of mammoth proportions roamed over the earth. The pictures they give us of these beasts show them to have been large enough and sufficiently terrifying in appearance to have exerted considerable influence in their respective spheres of action. They possessed, however, one fatal defect: they were too bulky to serve any useful purpose, and they perished one and all down to a few surviving representatives of no particular importance. Is the fate which overtook the iguanadon, the tyrannosaurus, and the triceratops to find modern exemplification in the case of the trusts?

The existing depression in general business is acutely felt by those connected with the mining industry. The smelting business of the country has gone into the hands of a very few large corporations, and small concerns have to a great extent been absorbed or forced to close. One of the shining lights in the mining world, (who reached prominence by dint of much advertising), is quoted as recently advising young mining engineers to apply themselves to farming as a profitable field for their energies. Now, cultivation of the soil is a noble occupation, possibly the best of any still open at the present day; but, like everything else, to achieve success experience and knowledge of the special requirements of the industry are essential. If a young man is to take up the vocation of a farmer, would it not be better for him to attend some one of the institutions properly equipped for imparting instruction along agricultural lines, and thereby save the time expended in obtaining a M. E. de-

gree, for which he will have small practical use when engaged in, let us say—raising cabbages? "Back to the land" by all means; but first obtain some practical knowledge of the essentials which every farmer's boy absorbs in the days of his apprenticeship, or else results are likely to be disastrous. The best preparation would be, of course, to hire out to some farmer for a few years before assuming individual responsibilities.

There is still another calling which has not yet been trustified—a case is known to the writer where one young mining engineer is studying to become a dentist, convinced that aching teeth are likely to bring more clients than his M. E. diploma.

It is not with theories that we have to deal—the trusts are painful realities. At a time when everybody should be prosperous, business throughout the country is receding, and many are already experiencing the pinch of necessity. The country is not threatened from any outside source, and it is difficult for the two great political parties to find separate platforms which may assist the outs in getting in and the ins in keeping the outs out. And yet business exhibits symptoms of distress, as though it were in the strangle-hold of some unseen monster!

We are told that the artificial conditions which have produced this state of affairs have come to stay!

UNDERGROUND WATERS

Water is found in some amount in all formations below the earth's surface, from the loosest and most porous sands and gravels to the hardest slate and granite. The amount varies from the merest trace chemically combined in the molecules of the rocks to immense reservoirs which supply wells flowing hundreds of thousands of gallons a day. Some waters are so pure that a refined chemical analysis shows only minute traces of organic and mineral matter; others are so heavily charged with minerals or other impurities as to be unsuitable for use.

The slope of the surface at any point is one factor determining the amount of water absorbed by the ground. The direction and amount of slope also determine the form of the water table—that is, of the upper limit of saturation. Except where the surface is flat the water table is generally not parallel with the surface; it is almost invariably farthest from the surface on the summit of hills and mountains and nearest to it in valleys and along the coast, reaching the surface in swamps and along rivers, lakes, and beaches. The surface of the water table is always in motion, its higher portions flowing toward the lowest outlets along rivers or the sea. This direction of flow explains why fresh water is usually found when a well is dug in a sandy beach.—From Water-Supply Paper 223, United States Geological Survey.

REAL OVERPRODUCTION

In 1908, the total of new securities issued in London up to the end of July was $654,000,000, which broke the previous record. In 1909, for the same period, it was $707,000,000; in 1910 it was $1,034,000,000. It was then that Lombard Street began to talk of undigested securities. Up to this date in 1911, the issues have been only $650,000,000, which shows that the warning has begun to have effect. In the three years, ending with 1904, London absorbed $1,925,000,000 new securities; in the three ending with 1907, it took $2,055,000,000; in the three ending with 1910, the unparalleled total of $3,210,000,000 was reached. Now comes the other side of the story.—Boston Financial News.

The dance has been held and enjoyed and now the fiddler wants his money. The lesson being taught is properly rated as severe, but it needs to be severe to have any lasting effect on the class which delights in having every bag of hot air recognized by the "investor" and money-lender as a "security." Let us quit talking about curtailment of the copper output and devote a little more attention to clipping the wings of the birds of prey who capitalize dollars for millions; who sell the stock and issue bonds convertible into new stock and then repeat the performance. It is not an overproduction of copper that is raising hob in the mining stock market. It is a failure to find "suckers" enough to absorb the loads of water-logged "securities."

SMELTING WITH OIL FUEL

In July Mr. Thomas Kiddie, metallurgist, of Vancouver, B. C., made a brief report to the Dominion Oil Smelting Co., Ltd., Vancouver, relative to a recent additional test of the use of oil as fuel in smelting copper ore, as follows:

"In compliance with your request, I proceeded to Van Anda, Texada Island, accompanied by Mr. Carlsrud, general manager, for the purpose of making a further demonstration with the oil-burning furnace. Two days were there occupied in overhauling water pipes, machinery, furnace engine, blower, and water and oil pumps, all of which were tested before the demonstration was begun.

"The ore mixture smelted consisted of Boundary district ore, iron ore as a flux, and copper slag from a previous operation. The furnace was started at 11 o'clock a. m., using two burners until it became sufficiently heated, when two more were started. Everything went along satisfactorily and slag began to flow at 12 o'clock, noon. The slag was hot and increased in quantity until it ran a pot of slag in one minute of time up to 2.30 o'clock p. m., during which time it smelted without trouble or interruption.

"Allowing one hour for the heating up of the furnace—a very conservative allowance—we used 157 gallons of oil in 2.33 hours, and 60 gallons for heating up the furnace, or 217 gallons in all. This gives an average of 14.6 gallons of oil per ton of material smelted, equal to 43.8 cents per ton of ore. The rate of smelting was 110 tons per 24 hours, an increase of more than 100 per cent over the results obtained during the best previous demonstration.

"I have no hesitation in saying that these conditions can, and will, be much improved upon after certain changes shall have been carried out, so that full advantage may be taken of better and more complete combustion of the oil, when the cost of oil consumed per ton of material smelted should approximate 30 to 35 cents per ton of ore. The saving of labor costs at the furnace I estimate at nine cents per ton of ore.

"As a result of this and previous demonstrations, I strongly recommend that the furnace be remodeled along the lines already submitted by me to your company, and endorsed by at least two metallurgists of the highest standing in British Columbia."

The company decided to proceed at once with the remodeling of the furnace, as recommended by Mr. Kiddie.

Drill steel having a high carbon content should not be heated above a clear red heat and in an ordinary forge care should be taken that drill bits are well covered by the fuel. The blast should not impigne directly upon one drill or parts of it so as to cause local overheating. Drills should be constantly turned in the fire. Inasmuch as different steels require to be heated and tempered in differnt ways, it is well that the man at the forge have but one grade of steel to work with at a time.

Depth of some of the main shafts in the Kalgoorlie, Australia, goldfield is as follows: Great Boulder Proprietary, 2,800 ft.; Sons of Gwalia, 2,440; Ivanhoe, 2,270; Great Boulder Perseverance, 2,100; Golden Horse Shoe, 2,100; Chaffers, 2,100; Asscociated, 2,000; Lake View & Star, 2,000; Kalgurli, 1,850; South Kalgurli, 1,800; Associated Northern, 1,100; Hainault, 950; Golden Ridge, 500.

IN PALMY DAYS OF LONG AGO.

ONTARIO SILVER MINING COMPANY BECAME WORRIED WHEN MILL TAILINGS CARRIED VALUES OF $33 PER TON.

In these days of intricate, painstaking work on the part of metallurgical, mining and mechanical engineers, to solve problems that will permit of profitable operation of mining properties the resources of which are measured in ores the metallic contents of which range from $2 to $5 or $6 a ton, it seems almost unreal to read and hear about matters and problems that worried the operators of mines and mills in days long gone by.

Thirty-three years ago the Ontario Silver Mining Company, operating at Park City, Utah, became so worried over the fact that "owing to the rapid increase in the proportion of base to free ore, *** the value of the metal left in the tailings has risen from $3 and $11 to $12 and $33 per ton, which is anything but satisfactory." Just think of that, you present-day metallurgists; just think of tailings from a stamp mill running $33 per ton and the president of the company reporting that the condition had become so unsatisfactory that he had taken the precaution to employ a metallurgist "to inquire into the defects of our methods and to suggest remedies." That seems like a tremendous loss, does it not?

Following these introductory remarks we are reproducing the letter of President J. B. Haggin of the Ontario company and the report of Mr. Frederick Gutzkow, the San Francisco metallurgist who made the investigation and suggested a remedy, confident that the papers will be found interesting and educational, and particularly so because the tremendous losses sustained in milling the silver ores of the Ontario were, after all, no greater in percentage of value than those being sustained by many of our low-grade mines of the present day—and nothing like as great, for instance, as those prevailing in the treatment of low-grade copper ores—at the Utah Copper, for example. While the Ontario's losses reached $33 per ton, that was only 24¼% of the total contents of the ore, as against 35 to 45% of losses by the Utah Copper Company, with all its boasting and all the laudation of its chief sponsor as "the greatest mining engineer in this or any other country."

The accompanying reports will be interesting, also, as indicating what a wonderful mine the Ontario has been. The ores near the surface were "free milling"—that is, they contained little lead, zinc, or other mineral in sulphide form to interfere with the making of good recoveries by the old amalgamation process. In those days there was no hesitancy at all in burning out the lead that began to appear in the ore in order to save the silver and, even when Mr. Gutzkow made his report, April 30, 1878, it was a matter of concern that the silver bars produced be given as good an appearance as possible, as that had a bearing on their market value.

Incidentally, and for the benefit of lay readers, it may be stated that the Ontario company has paid nearly $14,000,000 in dividends, while the gross production of the mine cuts close to $40,000,000. The prospects also are that it will yield a great deal of silver, lead and copper in the future as there are great quantities of low-grade ores in the deepest levels that are yet practically untouched.

PRESIDENT HAGGIN'S LETTER.

"The results obtained from the base ores of the company by the use of a Stetefeldt furnace during the first six months of 1877 were very good, but owing to the rapid increase in the proportion of base to free ore during the past fifteen months, the value of the metal left in the tailings has risen from $3 and $11 to $12 and $33 per ton, which is anything but satisfactory. As, however, the latter figures have been touched only since the development of the ore body on the 500-foot, or lowest level of the mine, it is reasonable to suppose that no worse results will be obtained, even should we fail to make any improvement in our methods of working until we sink deeper.

"Knowing from the past history of the Ontario that, while its ores were constantly increasing in richness as they were developed in depth, they were also getting more and more base, it has been my constant endeavor to ascertain wherein our processes are defective, and to have the improvements in them keep pace with the change.

"My last effort in that direction was the employment of Mr. Frederick Gutzkow, metallurgist, to inquire into the defects in our methods, and to suggest remedies. I enclose herewith, for the information of those interested, a copy of his report.

"Mr. Gutzkow is now engaged in making thorough anaylses of our ores and bullion, from which we expect to derive information of material importance.

"After a complete and more thorough investigation of the subject, I shall adopt some plan to remedy the present defective system of working our ore."

GUTZKOW'S REPORT.

J. B. Haggin, Esq., Dear Sir: Having returned from my journey to the Ontario mine, I present in the following my report on the two questions into which you desired me to examine:

1. The causes of the apparent increase of loss in tailings. The ore of the Ontario mine has been and is still divided into the "Free Ore" and the "Base Ore," both being worked separately and in about equal quantity, that is, thirty tons a day of each kind.

The "Free Ore" is gradually giving way to the base, being in fact nothing but the partial decomposition of the latter in the upper levels of the mine, and will be worked out probably already toward the end of this year. Even now, its quality as a milling ore has deteriorated. It is much intermixed with base ore and appears to be in character similar to the ore which was formerly called base and subjected to roasting. As is natural under these circumstances the returns from the working of free ore have become less favorable. Whilst in the last year the tailings from the latter have rarely exceeded 9 per cent of the value of the ore, the average for the first eighteen days of April, 1878, has been 12½ per cent, namely, $11.67 in the tailings, to $96.70 in the ore. As this result is still favorable enough, and as the "free" ore will soon give way to the "base" anyhow, I directed my examination principally to the latter.

The "Base Ore."—The loss in silver by the higher value of the tailings from the "base" ore dates from the beginning of this year. The assay book of the mill shows a sudden and unmistakable rise in the value of tailings from the 1st of January to date. Whilst in December, 1877, the tailings were only 7-8 per cent of the silver value of the ore, they average during the first eighteen days of April, 1878, 24¼ per cent, namely, $33 to $136 in the ore. Fortunately, there is a corresponding rise in the value of the ore, so that the returns in bullion are not affected.

These changes coincide with the opening of the 500-foot level of the mine. The ore shows itself there, whilst not yet free from signs of partial decomposition, contracted into a mass of sulphurets, which is a favorable indication of the continuity of the lode. As the stoping from the 500 to the 400-foot level has barely commenced and the "base" ore furnished to the mill during the last month came principally from the opening of the 500-foot level, it is obvious that for a time—that is, until a still lower level has been opened—the ore has shown its basest character, and a further deterioration need not be expected.

EXPERT'S FINDINGS.

The change in the proportion of silver which the base ore yields in the mill coincides, however, not only with a change in its character but also with a change in the working of the roasting furnace. The weekly chlorination tests made in December, 1877, show that the silver was converted into chloride to the extent of 80-70-77 per cent in the shaft, and 87-90-86 per cent in the flue of the roasting furnace, with correspondingly good results in the pans, as stated above. In April, 1878, they have dropped to 55-32-28 per cent in the shaft, and 81-77-63 in the flue, and the value of the tailings has risen in direct proportion therewith. Considering the low chlorination of the last months, the pan work was satisfactory enough, and proves that the roasting did good work in preparing the ore for the pan process, even if a less high chlorination was reached than formerly.

In studying up the reasons why the chlorination has dropped off, I commenced by separating and assaying the minerals which join in giving the ore its base character. I found the following minerals to be present in considerable proportion, and to contain, according to the assay of Mr. Gallagher, in silver per ton:

Iron Pyrites	$ 13.56
Zinc Blende	35.43
Antimonial Copper Ore	54.29
Galena	174.96

Of these four minerals I found that in the shaft of the Stetefeldt the iron pyrites is entirely decomposed; the zinc blende to a very large extent; the antimonial copper ore to at least one-half; the galena not at all.

The galena is easily distinguishable in nearly every piece of rock as well as in the roasted ore. This, coupled to the fact that the bullion contains no lead, and to the richness of the galena, shows where the increase in the value of the tailings comes from. From assays made by Mr. Watkis as to the percentage of lead in the ore, I deduct that about $10 per ton of tailings is carried away by the undecomposed galena. It is a matter of course that the difficult roasting of one mineral, of which there is at least 5 per cent in the ore, prevents also the complete roasting of other and perhaps richer minerals with which it may be mixed.

The question now arises how the decomposition of the galena may be effected.

The Stetefeldt roasting furnace has many advantages. It works cheaply in fuel and labor and surpasses all others in capacity and durability. But its greatest virtue is at the same time its disadvantage—I mean its unalterableness. A bad management cannot spoil, a good one cannot improve it. As long as the feeding machinery is kept in order, the fire maintained and the ore properly withdrawn, the most shining metallurgical star and the darkest ignoramus are about on the same level. Still, although I consider a change in working the Stetefeldt furnace, as it stands, a difficult and risky task, I think in building a new furnace an improvement might be advisable. It consists in this: To dispense with the present method of drawing the red-hot ore into a cart and dumping it on the cooling floor, but to allow it to fall directly from the furnace on a covered hearth, say 30 ft. long, 8 ft. wide, 2 ft. high, pitching under an angle of about thirty degrees to the cooling floor. As it is now, the ore is withdrawn from the furnace in the very midst of the roasting process, steaming off copiously sulphurous gas, to the great annoyance of the furnace-men. By the improvement which I suggest the ore gets a chance to finish, as it is kept on the inclined hearth red-hot with free access of air for one or two hours. I cannot see any increase of costs for fuel or labor in the new arrangement, and the natural slope of the hill on which the new furnace would be erected favors it. If it works well at the new furnace it may easily be adapted to the old one.

If the ore is allowed only time enough, there is no trouble in bringing the ore to the proper state of chlorination. The same "battery-samples" which on the large scale were chloridized only 30 or 40 per cent, yielded in the muffle of the assay furnace in three experiments respectively 66-74-80 per cent to the chlorination test, and by increasing the proportion of salt I got 90 and 85 per cent.

In connection with a new furnace, I propose another change. I refer to the drying-kiln. The present arrangement is not only very expensive in its first construction, but also costly to work and a dangerous nuisance to the men, who have to be induced by high wages and short hours to work there. Not to mention the disagreeable necessity for the men to walk on hot plates all day long, there is much danger to their health from the arsenic which the ore contains, and which begins to roast off at a very low temperature. The garlic-like smell of arsenious acid is occasionally quite noticeable and may give rise to bad accidents any day. Besides, the cleaning of the labyrinth of flues underneath necessitates a stoppage of the whole mill for a week or more every three or four months. The view of saving the fine ore-dust has been here carried out too far. From the flues under the drying-kiln there are gathered about 50 tons every three and one-half months, assaying considerably under the average ore, and representing for about 3,000 tons roasted during that period barely 1 per cent in value.

IMPROVEMENT SUGGESTED.

The improvement which I propose is: To conduct the waste heat from the roasting furnace to the chimney, which this time ought to be placed higher up on the hill, through an ascending flue, covered with iron plates about 8 feet wide. This flue will connect the ore-chute directly with the battery-hopper. Thus the wet ore will move gradually to the hottest place, can be discharged to the hopper as soon as finished, and the man may work the kiln from the outside. There is only one place—at the bottom of the incline, where the hot gas enters—that might possibly get overheated, and here a wooden hood and chimney could be placed to carry the deleterious gas through the roof. As the flue can easily be reached from the outside for its whole length, there need be no stoppage of the mill in order to clean it.

With regard to the loss in tailings—still referring only to the "base ore"—I found that the loss is currently overestimated. It has been assumed that one ton of ore gives one ton of tailings. This is not so. By repeated experiments I determined the following facts:

(1) The dry ore, as it comes from the battery to the furnace charged with 15 per cent salt, loses in the furnace 17 per cent in weight by volatilization. I do not refer here to the loss in flue-dust.

(2) The roasted ore loses 3 per cent more in the pan by the dissolving action of water

In summer, the loss is 25 per cent in weight, that is four tons of "battery-ore" yield only three tons of tailings.

Calculated for the average assays of $136, and $33 for ore and tailings in April, 1878, the returns would be—

Four tons of "base ore," at $136 ...$544

Yield three tons of tailings, at 33 ... 99

Extracted 81.8 per cent.

And not

Four tons of "base ore," at $136 ..$544

Yield four tons of tailings, at 33... 132

Extracted 75.7 per cent.

If this new calculation is correct, then the percentage of silver in the roasted ore ought to be higher than in the "battery ore," because its weight is so much less. And such is the case. The average of the first eighteen days in April, 1878, shows the assay of the ore, from the shaft, to have been $150 against $136 in the "battery ore."

The circumstance that the "battery ore" loses 15 per cent salt by treatment with water, whilst the "roasted ore" loses only eight (and the largest portion of those 8 per cent is sulphate of soda, the final product from the decomposition of the salt), combined with the fact, that in numerous experiments in the assay-muffle, I always obtained higher chlorination by the addition of more salt, proves that there is either an insufficiency of salt, or an enormous loss by volatilization.

I had no time to follow these points up. They show, however, that there is plenty of room for analytical work of practical value.

I have to suggest, that the actual weight of the "base ore," put through the mill, be more closely determined. At present, the "battery ore," although daily assayed, is not weighed at all. The roasted ore, as it goes to the pans, is weighed, but it is mixed with the roasted "fine ore," which assays differently, and is, besides, sprinkled with a varying amount of water. The weight of the ore, as brought from the mine, furnishes no criterion at all, as it changes daily in the proportion of water which it retains, and just now, owing to some very wet stopes, arrives frequently literally swimming in water. It would be an easy matter to keep the roasted ore from the shaft and flue, which are daily assayed, separate, and take note of their weight. The moisture ought also to be occasionally determined. The weighing of the "battery ore," though not so easily effected, would be greatly preferable, as it would show how much ore has actually gone in and the out-turn in bullion would allow you to strike a surer balance than by any other calculations.

CHAMBERS' GOOD IDEA.

Mr. R. C. Chambers explained to me an idea of his, which will doubtless work well, namely, to determine by a series of assays, which tailings are poor enough to be allowed to run to waste (say from the upper two plugs in the settler), and to save only those above a certain average assay. Thus, a concentration of the tailings could be effected in the cheapest possible manner, and their bulk greatly diminished, a consideration of much importance, as there are certain local impediments to catch the tailings in spacious reservoirs. Those assays might, at the same time, be used to control the present method of sampling the tailings, and prove whether my doubts as to its correctness, and the preference I give to the method in use at the Comstock mills, is well founded.

In the melting room, I had many improvements to suggest regarding the proper way of skimming and toughening the bullion, of smoking the moulds, pouring the bars, and so forth. The melters ought not to be restricted in the use of more borax and nitre; the first, in order to get a more fluid slag on the metal, and, consequently, to get less grains into the skimmings. Not to mention the bad plan of keeping so much valuable matter out of circulation—the grains from last year's work gave more than four large bars—its stamping up in the battery passes it altogether through too many hands. Nitre ought to be used, in order to remove the iron, which always spoils the appearance of bars. A proper mixing and stirring of the metal in the crucible is imperative. No carefulness of assay will prevent reclamations, as long as the bar itself it not thoroughly uniform. The molten bullion ought to be covered with powdered charcoal, as soon as the assay is taken, and the melter be supplied with that article. The mould ought to be smoked with rosin, and not with the engineer's refuse and coal-oil. The metal ought to cool down before pouring, otherwise the bar will never have a smooth surface. The bars themselves ought to be covered with charcoal, as soon as poured, in order to prevent oxidation of the surface. All this extra trouble costs the company very little, and repays itself by the higher price which well-made bars invariably fetch in the market, giving the buyer more confidence in the correctness of weight and assay.

Whilst I had much to suggest in the melting, I found the retorting well and carefully done. The retorts are not overcrowded, as is frequently the case, and they need, consequently, no overheating. Owing to its baseness, the amalgam is very wet, there being six parts and more of quicksilver to one of bullion. Wrapping a piece of it in canvas, and squeezing it in a vice, I could easily remove nearly one half of the quicksilver. A hydraulic press, such as used at the mint, for compressing the spongy gold and silver, would give still better results, and allow the work of three retorts to be done in one.

RAISING BULLION STANDARD.

The bullion produced at the Ontario mill averaged, in March, 1878, 812 in silver. That obtained from the "free ore" is mixed with that from the "base ore," the former assaying 950 and over; the latter, 611 and less. The metal is, according to Mr. Trelan's analysis and my own observation, nearly exclusively copper. The amount of copper in the "base ore" is small, only one-quarter per cent, or five pounds per ton, by Mr. Watkis' assay. There being about ten pounds of silver per ton of ore, of which about seven and one-half pounds are extracted, which require for a fineness of 611, four and three-quarter pounds of copper, it is obvious that nearly the entire copper in the ore is going into the amalgam. I ought to add, that lately no blue-stone is used on the "base ore." There is fully as much copper in the "free ore," but it is in the shape of oxide and carbonate, both insoluble in water, and not acted on in the pan process. Now, it would be an easy matter to convert the soluble copper-salts in the roasted ore into the same insoluble compounds as exist on the "free" side, by the addition of a little carbonate of soda. But as long as the chlorination is low, the soluble metallic compounds, especially those of copper, are required to do much work in opening the undecomposed sulphides, and I have no doubt that they do the work, or the results from the pan-work would be less favorable.

The cheapest possible way of refining your bullion, that of preventing the copper to enter the amalgam, being thus precluded, I examined into the next cheapest process, that is, to make the copper, which has entered the amalgam, available and valuable, to defray the parting-expenses by converting it into blue-stone, and I am glad to state that I do not anticipate any particular difficulty in doing so.

PROCESS PROPOSED.

The process, which I propose, is very simple. It consists in dissolving part of the retorted bullion (previous to melting) in strong sulphuric acid; to pour the solution in water, and add to it the rest of the bullion. The metallic copper, in the latter, will precipitate the dissolved

silver into metallic silver, and be itself dissolved instead. The result will be a spongy mass of fine silver, which is washed, dried, and melted, and a solution of sulphate of copper, which, when brought to crystallization, will yield crystals of the commercial blue-stone. The blue-stone, thus obtained, will be of a superior quality, as there is no method in existence by which a purer article can be manufactured. A roasting of the retorted bullion (that is, keeping it red hot, with access of air, for some hours) will facilitate the operations, and save acid, but it is not necessary. There is no silver lost in this process, nor any other by-product but blue-stone obtained.

The two questions which I had to settle by actual experiments were: (1) Will the retorted bullion dissolve in strong sulphuric acid, and (2) is it in the shape as it comes from the retort porous enough to allow the other reaction?

In experimenting on pieces of retorted bullion, between 700 and 800 fine, of the size of a walnut in the laboratory, I easily and repeatedly obtained a silver-residue which, after melting, showed a fineness of 991.

I then operated on large pieces as they actually came from the retort assaying 800, and obtained from 21 pounds a bar assaying 940.

For a second experiment I roasted 50 pounds bullion from the base side, assaying 611, and extracted the oxydized copper by dilute sulphuric acid (metallic copper requires strong, oxydized copper only weak acid) melted one half of the residue down and obtained a bar 835 fine. This showed me how far the copper could be removed by roasting alone, to-wit:

In bullion 611 fine are mixed, 611 lb silver with	389 lb. copper
In bullion 835 fine are mixed, 611 lb silver with	121 lb copper
Removed by acid after roasting	268 lb copper

That is more than two-thirds of the copper.

Of the bullion of the original fineness of 611, of which one-half had yielded the bar of 835, the other half was "finished" in the manner described above, that is, a portion of it was dissolved in strong acid in an iron kettle and boiled in a lead-lined tub with water and the other portion. The result was a bar. The assay was not finished when I left, but from the appearance I think it will be high enough.

As I made the three bars under favorable circumstances and from pieces as they are actually obtained on the large scale, these three experiments were sufficiently convincing for myself. The test of considerations, the plant required and the method of working are perfectly familiar to me, not differing essentially from the usual refining operations.

Taking as a basis the product of March, 1878, I find that the Ontario mill shipped:

166.332 oz. bullion with 135.100 oz. silver and 31.232 oz. copper.

Equal to 11.392 lb avoirdupois with 9.253 lb. silver and 2.139 lb. copper.

Or per day 379 lb bullion with 308 lb. silver and 71 lb. copper.

This represents an average fineness per month of 812. Now, it will be necessary, if working the above process.

(1.) Without roasting: To dissolve in strong acid 40 per cent of 379 lb. bullion with 123 lb. silver and 28 lb. copper, and to precipitate the silver by 60 per cent of 379 lb. bullion with 185 lb. silver and 43 lb. copper—100 per cent—379 lb. bullion with 308 lb. silver and 71 lb. copper.

The 123 lb. of dissolved silver will be precipitated by 43 lb. metallic copper.

Acid Required:

To dissolve 123 lb. silver,	123	lb. com l con acid
" " 28 " copper,	93	" " " "
	216	" " " "
Add 25 per cent for loss	54	" " " "
	270	lb. of acid.

The yield in blue-stone will be 4 pounds for each pound copper—4x71—284 lb.

Expenses per Month:

1. Wages, 1 man at $150	$150 00
2. ½ cord wood per day = 15 cords at $4	60 00
3. ½ ton coal in steam-boilers = 15 tons at $9	135 00
4. 30 barrels for blue-stone at $1 25	37 50
5. Sundries	100 00
6. 30x270 = 8.100 lb. sulphuric acid at 2¾ cts in S F	222 75
7. Freight on Acid 8.100 lb. Acid. 1.350 lb Packages = 1-6 of 8.100 1.350 lb Packages to go back empty 10.800 lb. at 5 cents	540 00
	$1.245 25
Income: 30 x 284 = 8.250 lb. blue-stone at 11 cents	937 20
Net Expenses	$ 308 05

(2.) With roasting:

To refine per day as above, 379 lb. bullion with 308 lb silver and 71 lb copper.

Converted into Oxide by roasting, 35½ lb bullion with 308 lb silver and 35½ lb. copper.

Remains for "finishing", 343½ lb bullion with 30 lb silver and 35½ lb copper

To dissolve in strong acid 30 per cent, 103 lb bullion with 92½ lb silver and 10½ lb. copper

And to precipitate the silver by 70 per cent, 240½ lb. bullion with 215½ lb silver and 25 lb copper.

The 92½ lbs. of dissolved silver will be precipitated by 25 lbs. metallic copper.

Acid Required:

To disol 35½ lb. cop. as oxide.	59	lb of con acid.
" 10½ " " metal.	35	" " " "
" 92½ " " silver.	92½	" " " "
	186½	lb.
Add 25% of 35x92½ = 127½ lb =	31½	lb.
	218	lb of sul acid.

The yield of blue stone is as above—284 lb. per day.

Expenses per Month:

1, 2, 3, 4, 5, as above	$ 482 50
6. 30x218 = 6.540 lb Acid at 2¾ cts. in S. F.	179 85
7. Freight on Acid 6.540 lb. Acid 1.090 lb. Packages = 1-6 of 6.540. 1.090 lb. Packages to go back empty. 8.720 lb. at 5 cents	436 00
	1.098 35
Income, 8.530 lb. blue-stone as above at 11 cents	937 20
Net Expenses	$ 161 15

If a refining room is built at the mill, it should be constructed, however, with a view, that the "free ore" bullion will soon be replaced by "base ore" bullion. Assuming the same returns in silver as in March, 1878, and the fineness of all the bullion at 611, as the "base ore" bullion runs now, the account will stand:

Produced per month, 15.144 lb. bullion with 9.253 lb. silver and 5.891 lb. copper.

To refine per day, 505 lb bullion with 308 lb silver and 197 lb. copper.

Converted into oxide (as per exper.), two-thirds of the copper = 131 lb copper

Remains for "finishing," 374 lb. bullion with 308 lbs silver and 66 lb. copper.

To dissolve in strong acid 40 per cent = 150 lb. bullion, with 123 lb. silver and 27 lb copper.

And to precipitate the silver by 60 per cent = 224 lb. bullion with 185 lb. silver and 39 lb copper.

The 123 lbs. of dissolved silver will be precipitated by 30 lbs. metallic copper.

Acid Required:

To disol. 131 lb. copper as oxide.	218 lb	sul. acid.
" 27 lb. " metal.	90 lb.	" "
" 123 lb. silver.	123 lb.	" "
	431 lb.	sul. acid.
Add 25% of 90x123 = 213 lb. as loss	53 lb.	" "
	484 lb.	sul acid.

The yield in blue stone will be 4x197—788 lbs. per day.

Expenses per Month:

2 men at $150 and $120	$ 270 00
1 cord wood per day = 30 cords at $4	120 00
15 tons coal at $9 in steam-boilers	135 00
80 barrels for blue stone at $1 25	100 00
Sundries	100 00
30x484 = 14.520 lb. acid at 2¾ c. in S. F.	422 40
Freight on Acid, 14.520 lb Acid 2.420 lb. Packages = 1-6 of 14.520. 2.420 lb. Packages to go back. 19.360 lb at 5 cents.	968 00
	$2.116 40
Income: 30x788 = 23.640 lb. blue-stone at 11 cents	2.600 40
Net Profit	$ 484 00

It appears, therefrom, that the lower the bullion the higher is the yield in blue stone. Mr. Chambers anticipates no difficulty in selling a car-load or two a month to the mills in Utah or the northern territories. In case of need, Virginia City will take all.

The main point, which will decide on the rentability of the process, is the freight on sulphuric acid. I have to leave it to yourself to see what arrangements can be made either at the Central or the Union Pacific railroads' headquarters. I figured up 5 cents per pound. Deducting 1 cent for freight from Ogden to the mill, there would be left 4 cents per lb., or $800 per carload of ten tons for the distance, San Francisco to Ogden or Omaha to Ogden. The freight

from Omaha to the nearest acid works would be covered by the lower price of the acid.

The acid ought to be shipped in sheet-iron drums or cylinders, say 3½ ft. long, 2½ ft. diameter, with a hole for discharging secured by a screw plug. This kind of package is successfully used by the acid factories of this city since some years, to take their acid to the Giant or Hercules powder works. That is no experiment, therefore. To secure the railroad still more against damage, the car might be covered with sheet lead, so as to form an acid-proof tank, into which the drums are placed, plug-hole up. A package or drum of this description weighs about 300 lb., and holds nearly a ton of concentrated sulphuric acid.

Regarding the best site for a refining room at the Ontario mill, I held consultation with the superintendent and the head carpenter. The room would adjoin the retort room, be on the same level with it, and measure 60 by 38 feet, the roof sloping like that of the retort room. Mr. Chambers estimates cost of building and grading, at $2,000.

A rough but liberal estimate of the cost of plant gives me:

13,000 lb. sheet and pipe lead at 13 cents (freight included)	$1,690
Castings	1,000
Carpenter's work and material	500
Mason's work and material	500
Plumber's work	1,000
Sundries not foreseen yet, say	1,310
	$ 6,000

Within the building should be left a place for a brick vault, to lock up the bullion (badly needed now) and for a reverberatory furnace for the case, that at some future day the bullion should become more impregnated with lead and require a cupellation of the refined silver. Each of these two additions would cost about $1,000 extra.

Respectfully yours,

FREDERICK GUTZKOW.

No. 18 Columbia Street, S. F., April 30, 1878.

The beautiful tints which distinguish gems and ornamental minerals are due to "impurities," usually the oxides of the common or rare metals. The clear sapphire is said to owe its colour to iron oxide, while the fine blue of the Oriental gem is ascribed both to iron oxide and titanium oxide. This latter conclusion is indicated by analysis and synthetic experiments.

The Caylloma silver mines in Peru have an altitude of from 12,000 to 17,000 feet. They are believed to be the highest mines in the world.

PRESERVATION OF CORES IN DIAMOND DRILLING

By A. H. MEUCHE*

The volumes of the Lake Superior Mining Institute contain many articles on diamond drilling. Most of these papers deal with the curvature of drill holes and methods of observing the true angle of dip. As a result of these papers the diamond drill operators are supposed to test the angle of their holes at frequent intervals and then the angle etched on the bottle is corrected for capillarity. I am heartily in accord with this survey of bore holes but often wonder, inasmuch as no attempt is made to determine their lateral deflections, if these surveys and corrections are really worth while.

Besides these, there are many matters which should be considered by anyone having lands explored by means of diamond drills. Two of the most important are the preserving of the bore holes and the preserving of the records. In the copper country, where I have had most of my experience, the usual practice is to pull out the stand pipe when the hole is completed, thus making it impossible to reopen the hole and continue to a greater depth, if the occasion should ever arise when it might be advisable to do so. Of course, this question must be answered separately for each and every drill hole, as it becomes necessary to consider the policy of the parties having the drilling done, the cost of leaving the casing compared to the total cost of the hole, and whether or not for geological reasons it is definitely known whether any occasion may ever arise for deepening the hole. By this I mean that you know definitely that ore does not lie at any greater depth.

In the Copper country geological conditions answer the question many times. Here, as most of you know, the beds usually have a pretty steep dip and cross-sections are made by drilling a series of holes in a line at right angles to the strike and placing these far enough apart so that the bed exposed in the bottom of one hole is also found in the top of the adjacent hole.

There are two methods in which cross-sections are drilled. The most logical is to start at the extreme eastern limit of your property or at the limit of the copper bearing range, and work west. In this method it is necessary to bore the holes until you are positive of having a lap. The objection to the method is that it is not always possible to bore the holes as deep as you wish to go and then it is necessary to put down an intermediate hole. The other method is to start from the west and drill your hole as deep as you can, or desire to, compute the horizontal distance covered by the hole, deduct a little for lap and locate your hole to the east. This method works fairly well, especially for two drills, but is open to many objections. Suppose you find a fairly rich copper bearing lode, near surface, ine one hole and would like to examine it at depth. It may only be a few feet below the bottom of your preceding hole, but if it has been discontinued and the pipe pulled out, these examinations would necessitate a new hole, duplicating largely work which has already been done. Again, you may make a mistake in your computations, or the dip may be steepr than you thought it was. Under these circumstances you may have a gap in your section. Another trouble lies in the fact that even though the holes do lap, you may not be able to recognize them.

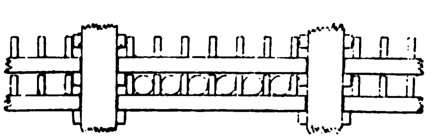
All these objections and troubles occur quite frequently and have come within my own observations. Ordinarily the first method is the better one to follow, but there are many times when it is advisable and sometimes necessary to use the second. If the latter method is used, I strongly advise leaving the stand pipe.

Another matter which has become a sort of hobby of mine is the care and preservation of drill cores. Perhaps this is due to the fact that I have examined in the neighborhood of 100,000 feet of drill cores during the last few years. I have seen cores kept in a limited number of boxes; when these boxes became full the cores were dumped out and the boxes refilled. I have seen core boxes kept in a cold, wet cellar, one box piled on top of another, forming a high stack. Often the lids are nailed down tighter than the bottom is nailed to the box, so that in trying to pry off the lid the box falls to pieces. I have climbed upon racks, pulled out boxes (not having covers) that were slipped in sideways, balanced them on my finger tips and tried to get down. Once or twice the boxes turned upside down.

With these experiences you can readily perceive why the method used by the Victoria Mining Co., and later adopted with some minor changes, by the Mass

*Proceedings of Lake Superior Mining Institute, Houghton, Mich., August 22-24, 1911.

Consolidated Mining Co., appeals to me. In both cases they have rigged up a sort of cabinet, using the core boxes without lids as drawers. The boxes slide lengthways into a rack or cabinet. The boxes or trays are stacked so close together that the bottom immediately above acts as its cover. At the Victoria, a strip the full length of the box is nailed on either side, forming the slides for the drawer. A drawer-pull and a label giving the number of the hole and the depths of the hole from which the core was taken is fastened to one end of the box. At the Mass they have overcome the necessity of nailing strips to the sides of the box by allowing the bottom of each box to extend about half an inch on either side. The boxes are made about 5 ft. long, which is a convenient length to handle, and holds enough core for ordinary purposes. The cabinet itself is made very similar to any ordinary cabinet, holding drawers, except that it is not necessary to put a piece of wood under each drawer as a stiffener. If the sides are made of 2-in. material, a stiffener need only be introduced about every 10 boxes. Sides or partitions are made for each stack of core boxes and as high as desired. These had better be made pretty heavy, as they must support the entire weight of all the boxes in each stack, and in order to make the construction as slow burning as possible, I would suggest a tight partition. Strips are nailed on both sides of these partitions to catch the strips on the boxes, thus supporting them. These strips should be placed just far enough apart to allow easy and free sliding of the boxes.



The accompanying sketch will explain the construction fully. The advantages of this system are the convenience in referring to the cores at any time and small amount of space required. Each box occupies a space of 10⅞x2 3-16 ins. Allowing one stiffener for every 10 boxes, 30 boxes can be stored in a stack 5 ft. 9 ins. high. As each box holds 30 ft. of 1⅛-in. core, which represents approximately 40 ft. of drilling, one stack would represent 1,200 ft. of drilling. Ten such stacks, representing 12,000 ft. of drilling, would only occupy a space 6 ft. high, 10½ ft. long and 5 ft. deep. I do not believe that the same number of boxes with covers screwed on could be gotten into the same space, and I question if the lumber and screws used for a cover would cost as little as would this scheme. The only objection to the scheme is the trouble involved in transporting the boxes from the drill. The Mass Mining Co. solved this by making boxes with hinged covers and locks which would just hold one core box. The core box was then placed in the box, which was then locked and sent to the mine office. For shipping, the core boxes could be crated readily enough.

I wonder, with such a convenient method as this of storing cores, if as much core would be thrown away as is now done. After so much money has been spent in obtaining the records it seems too bad to see the true records destroyed. I often encounter the argument "Of what good are they?" They usually are no longer of any use to you, but someone else may examine them and see something of great scientific or practical value. There is some excuse for a person holding merely an opinion on a piece of land to throw away the cores, as he may not have any place to store them but in those cases I truly believe that the Geological Survey should make an attempt to preserve the records.

CONSERVATION SHAM

The much used term "conservation" has come to mean, in the minds of politicians, the prevention of private ownership of anything that has thus far escaped this destiny, says Mining Science, of Denver. In their moments of professed frankness, such "conservationists" intimate a desire to prevent the monopoly of the resources of Alaska and other western regions. But the fact is that the proposals cited are clearly in aid of "monopoly." Only highly concentrated capital will be able to reap benefit from the restrictions that the government is asked to impose upon Alaskan development, for it alone will be able to meet the conditions.

MYSTERIOUS SALT SPRINGS

Geologists have as yet given no satisfactory explanation of the origin and occurrence of the very interesting salt springs (sodium chloride) at Salinas, San Luis Potosi, Mexico, about fifty-five miles northwest of the capital, says Mining Science of Denver. In the rock formation of the vicinity there is no indication of salt deposits and there is no evidence of the local origin of the saline waters. The springs are at an elevation of about 7,600 feet above sea level in a small basin of sand and calcareous matter. The surrounding hills are of cretaceous limestone and the basin is evidently an old lake bottom. All sub-surface water for many miles around is highly salty. The subterranean salt stream is charged with 1½ to 2 per cent of salt, but the ground is thoroughly saturated and adds to the salinity of the water of the springs. It is thought that the stream comes from the north, possibly as far a Chihuahua under some pressure. The springs discharge from a depth not exceeding twenty feet into a shallow lagoon, the spring region comprising some 600 acres. The lagoon is never more than ten inches deep and at times entirely dry with a surface crust of saline matter.

A TOAST TO LABOR

Here's a toast to every man,
Of every race, and creed and clan,
Who
By his manhood strong and free,
Digs from the earth, wrests from the sea,
Their treasures,
And whose arm and mind,
Leaves to his fellows—all mankind,
His heritage—his work.

So, here's to the man who digs the gold,
And here's to the man who makes the mould,
And here's to the man who mints the rim,
And here's to the man—good luck to him,
Who
By his strength of arm and mind,
Leaves to his fellows—all mankind,
His heritage—his work.

Here's a toast to the woman, too,
Man's comrade staunch, man's comrade true
Who
By her womanhood soft and sweet,
Coaxed into light from its dark retreat,
Man's treasures,
That his arm and mind
Might leave his fellows—all mankind,
His heritage—his work.
So, here's to the man who digs the gold
Who fashions its shape into wealth untold,
With water or wine—filled to the brim
We'll drink this toast—good luck to him
Who
By his strength of arm and mind,
Leaves to his fellows—all mankind,
His heritage—his work.

—HARRY IRVING GREENE.

In Houghton (Mich.) Mining Gazette.

Graphite can be distinguished from molybdenite, which it closely resembles, by the slightly greenish tinge of the streak of the latter and its sulphur reaction, when fused with soda before the blowpipe.

ORE SIZING WITHOUT SCREENS

McKESSON'S NEW SCREENLESS DEVISE IS CALCULATED TO CAPSIZE MANY PRECONCEIVED IDEAS AND PRACTICES IN MILLING.

By CHARLES J. DOWNEY*

To avoid quarreling with terms, the usual processes of separating fine sands and highly comminuted particles of ore may be divided into two broad categories: separation according to size and separation according to specific gravity. The other characteristics of minerals, especially of an electric or magnetic nature, which may be applied to the same purpose, are here disregarded. The first category is, generally speaking, that of sizing; and the second, that of concentration. Between the two, so to speak, is a complex of both: namely, separation according to both size and specific gravity; in other words, according to actual weight. In general, this receives the same classification. In the case of a homogeneous material, no differences of specific gravity existing, the functions of a classifier is that of a sizer; whereas, in the case of certain mixtures of minerals, it may approach the functions of a concentrator. Both pulp classification and concentration are commonly effected by the agency of water, while sizing, which usually means screening, is carried out by both wet and dry methods.

The elimination of water as a medium of classification and concentration, which is very desirable in some mining regions, has often been urged, but seldom without the substitution of air as an agency of separation. The reason for the substitution of air currents is that some such medium is considered desirable to produce the results incident to differences of specific gravity in the particles and differences in actual weight. In the province of screen sizing, where specific gravity is not the essential factor, the presence or absence of water is, roughly speaking, of immaterial consequence. If, however, the work of sizing is to be undertaken without screens, the natural assumption would be that the agency of water or air is necessary in some respect. The sizing of talc, for example, is now carried out by a pneumatic process† while, as already indicated, the function of a water classifier is partly that of a sizer, when not altogether so.

It has been found that the substitution of air for water as a medium of separation according to specific gravity, that is, for concentration, requires a high velocity of air as compared with that of water. "The effect of density in water," says Dr. Richards, "is equivalent to the effect of velocity in air."‡ Hence, to produce a sizing process in which screens are eliminated, without at the same time accomplishing classification according to actual weight of particles or the mere differences of specific gravity, the advantage of using neither air nor water as a medium would seem to follow as a corollary, provided the requisite mechanical conditions are present and some mode of agitation is provided to take advantage of mere differences of size. In other words, the elimination of a floating medium is desirable in order that the process may be restricted solely to sizing. While air would certainly be present in the atmosphere, it possesses no practical influence when at rest.

The McKesson Screenless Sizer is the name given to a new device which apparently overturns much preconceived opinion, for, while resembling a concentrating table, the process of concentration is non-existent, and its function is, for all practical purposes, confined to the separation of particles according to size. Differences of specific gravity exercise such a very small influence that the machine aroused unusual interest among those who have seen the first demonstration in Denver; though, after reflecting upon the principles which require a floating medium, either water or air, to effect concentration according to specific gravity, the absence of both would seem to me, negatively at least, to account for the results from the McKesson invention as a sizer, without the confusion that would result from any other kind of separation. The McKesson table uses no floating medium whatever.

In usual screen sizing it is well known that there is an absence of desirable efficiency when dealing with very fine material, and for this reason, in ore mills, water classification is adopted to accomplish results not to be secured by mechanical means. While the McKesson sizer has not been fully tested or its possible applications and limitations determined, it is evident that the machine as it now stands and operates produces very favorable results in the separation of the finest pulp, where it grades off into dust that would necessarily be collected by a suction fan, if present at all.

The sizer, it is stated, can be adapted to granular material of any size or mesh from rock and gravel to the finest pulverulent material. The sizer which I saw is adapted to material from 6 or 8 mesh up to the finest granular product. There is special provision made to cut out all over-size material so that it can be returned for regrinding.

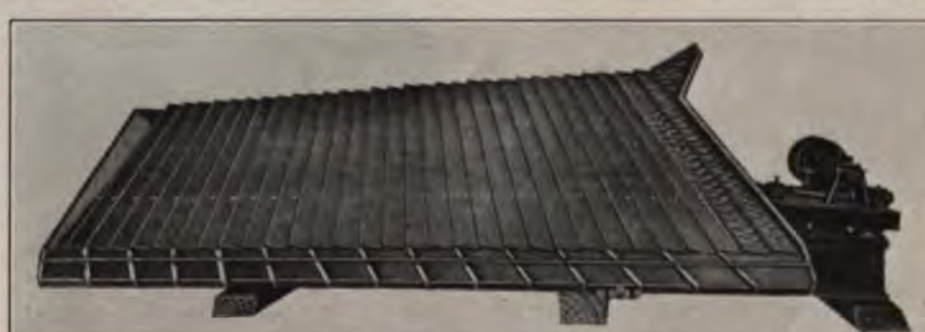


Fig. 1. Showing Deck of the McKesson Sizer

In the demonstrations that have been made of the invention, fifteen products are turned out, ranging, according to the character of the material, from a possible minimum of 8 mesh to more than 200 mesh. This is accomplished on an inclined surface having a horizontal and sharp vertical movement, the separation being, in general, the result of mechanical agitation.

Inasmuch as this invention is either based upon some new principle, or has thrived upon the rejection of principles that are serving well in other directions, a description of the mechanism and its operation will doubtless prove of value. The sizer is the invention of C. L. Mc-

*In Mining Science, Sept. 14, 1911.

†"Talc Milling and Pneumatic Classification." J. S. Diller; Mining Science, August 24, 1911.

‡Ore Dressing. Vol. II, second edition, page 826.

Kesson and B. F. Rice of Colorado Springs, and the patents are controlled by the McKesson Separating Co. The consulting engineers for the company are Lippincott & McClave of Denver, and the machine has lately been publicly exhibited at the ore testing plant of Henry E. Wood & Co., Denver.

The accompanying cuts, Figs. 1, 2 and 3, represent sectional drawings of the machine, a front view in perspective, showing the deck, and a rear view in perspective showing the driving mechanism.

The deck of the machine is supported by agitating mechanism which will be described after the deck itself is considered. In general, this resembles a concentrating table, but it is inclined at an angle of 38 degrees from the horizontal. This angle of incline bears upon the narrower of the two dimensions, or the width, of the deck. There is no dip in the direction of the longer dimension, but the surface is broken up into what may be described as steps, called deflectors because of their function of distributing the successive sizes of pulp after the fashion of channels. These steps or deflectors cut across the narrow dimension of the deck and follow approximately the dip of the table; though, to be exact, the lines of the edges correspond to radii of a circle, the center of which should be found at a point several yards above the highest border of the plane. Thus the lower border of the deck would tend to assume the shape of an arc of this imaginary circle, if there were any practical object in making it so. The horizontal dimension or width of the steps is 5¼ ins. at the top of the deck, and they are 1 in. wider at the bottom.

The effect of the circular measurement is noticed when one considers the surface of the deck, which consists of a covering of rubber matting containing grooves or corrugations. The matting is so cut and laid upon the steps that the grooves follow a course across the table parallel to the circumference of the imaginary circle. That is to say, at the feed end of the table, the grooves incline downward toward the center of the bottom; at the center of the deck, the grooves run parallel with the horizontal motion of the table, while, at the farther end, the grooves dip up with respect to the horizontal movement. The steps themselves have a drop of 1½ inches.

While we do not forget the circular nature of the measurements as applied to the corrugations of the deck, that is to say, the radical character of the steps and the curvilinear arrangement of the grooves in the rubber matting, the deck as a whole is, for all practical purposes, almost rectangular. It is 6 ft. in width at the feed end and 15 ft. in length. It tapers to 4½ ft. in width at the end opposite the feed. As already stated, it sits at an angle of 38 degrees. The matting grooves are very regular corrugations, approximately V shaped, and they are about ⅛ in. in depth. In none of the illustrations accompanying this article can these grooves be distinguished. The length of the deck is sufficient to contain 30 steps, each of which may, in theory at least, be made to contribute a sized product. In practice, however, the deflectors are operated in pairs, or nearly so, and at the bottom of the deck, where the successive products are cut out, the cutters are so arranged as to be adjustable during operations.

The deck has a progressive horizontal movement, aided by a sharp upward motion, which produces a sort of dancing effect among the particles of pulp. This result is produced by the bearings and the driving mechanism. There are four toggle supports set at an angle of 55 degrees, and the sharp vertical action is due to them. In other respects the movement is similar to that of a concentrating table, the horizontal motion being toward the left in the design and the perspective views of the deck (Figs. 1 and 2).

At the upper right hand corner of the deck is the feed spout, and from this point the pulp distributes itself to the left across the deck with a tendency toward the horizontal direction. The separation, however, is noted when the pulp begins to distribute itself in sized particles along the dip of the plane, that is, by way of the deflectors or steps, through which the sized products roll out at the bottom in successive receptacles. The pulp thus takes two directions, between which there is a median area, representing the general domain of agitation in which each size selects its outcome.

The upper border of the pulp line, along which the fines take their course, follows the corrugations in the rubber. That is, the fines descend slightly at the feed end and then ascend towards the upper edge of the deck and discharge from the top to the bottom of the final deflector at the end of the deck opposite the feed. The over-size particles are carried down the first two deflectors by means of a series of baffles, and discharged at the lower edge of the deck slightly back of the final spout. The baffles serve the purpose of keeping the oversize, coarse particles from bounding and rolling down the deck under the force of gravity.

As the pulp distributes itself to the left, the successive steps interrupt the process and aid the agitation in such a way as to cut out the particles of uniform size, beginning with the larger on the right and ending with the smallest on the left.

The selective action is assisted by the changing position of the deflectors and the corrugations in the rubber on the deck. The cutters at the bottom of the deck can be adjusted so that any required number of sizes up to 30 can be collected at one operation.

At a demonstration which the writer attended last week the machine was run at 320 r. p. m.

Concerning the theory of the McKesson method, I have no disposition to enter into a discussion of it, beyond what has already been said. An outline of the laws governing the selective action, in which differences of specific

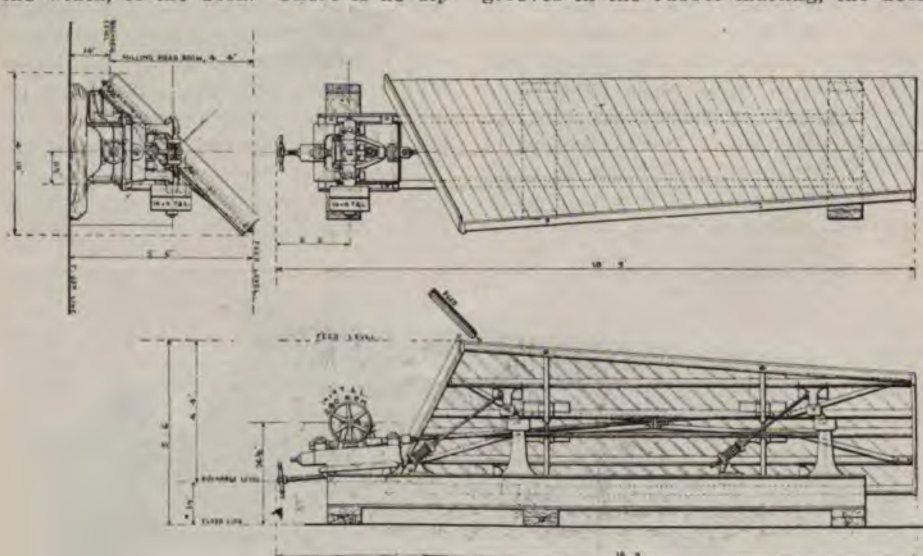


Fig. 2. Showing Rear Elevation, Horizontal Plan and Cross-Section.

gravity play but a very small part (and then only in the case of widely different minerals, according to the engineer), will be the result of systematic and prolonged experiment. That the sizing is effected to a high degree of efficiency is apparent to an observer, while the operation of the machine has all the aspects of simplicity.

Recent tests under the supervision of the company's engineers, some of the results of which have been available for the writer's inspection, indicate that the operations at average speed require about one horse-power. The length of horizontal movement and the toggle stroke determine largely the capacity, which has varied from 6 to 15 tons per 24 hours. After proper adjustments have been made on a given feed, the capacity can probably be increased, and it is estimated that from 20 to 25 tons can be handled commercially.

Screen tests of the several products have shown as high as 96 per cent efficiency, though at other points in the gamut the degree of efficiency may have fallen as low as 62 per cent. Such a low percentage is taken to indicate a faulty adjustment; in other words, that the under- or over-size at that particular point has not been satisfactorily diverted, either forward or backward. As the knowledge of the machine has increased, the tests have shown an average efficiency throughout the 15 products of 86.5 per cent, this being an expression of the degree of uniformity within commercial limits. It is clear, moreover, that a departure from uniformity of size should mean for the most part the presence or inclusion of under- or over-size from the grade next below or next above, the sizer itself disposing of the separation beyond the limits named. I offer this general statement rather as an indication of the problem to be considered than as a conclusion concerning what the machine may be expected to accomplish.

As a matter of general interest, it may be said that the method of sizing by this deck shows no concentration. In a mixture composed largely of galena and quartz, the over-size at a given point tends to show that the particles of galena are a little larger in sizes than the particles of lighter material, but there would be in case of a tendency to concentrate. The slight tendency to distribute larger, heavy particles in the zone of smaller, lighter particles becomes very interesting from the fact that this is a reversal of the effect of water classification, wherein small heavy particles report with large light particles. Theoretically one might expect the sizer to follow the hydraulic classifier in any variation from perfect sizing, but instead of doing that it entirely reverses that process. This fact excites much interest, as well as that of the closeness of diametric sizing done by the machine.

It shows that the mere mechanical agitation, effected both by the dual movement of the sizer, on the one hand, and by the stepping process and the grooves on the inclined surface, on the other, without the presence of a floating medium, either water or air (the latter being only the inactive atmosphere), produces a sizing result which is practically uncomplicated by differences of specific gravity among the particles.

It would be out of place at this stage of development to expect that the sizer has reached its highest degree of perfection, or that the range of usefulness of this new application of the principles here embodied should be fully known, but it appears that the sizer can successfully be used in many industries other than the milling of ores. The emphasis should be laid on the fact that the inventors and the engineers have developed a machine along entirely new lines and one that will supply wants not hitherto satisfied.

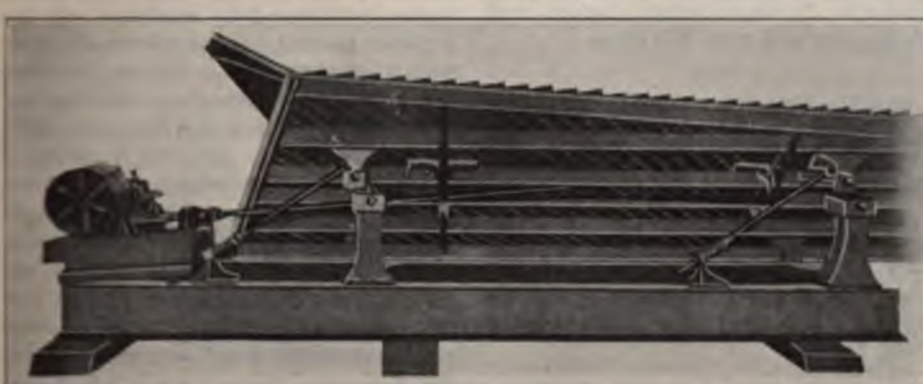


Fig. 3. Rear View of McKesson Table.

COPPERETTES

Walker's Weekly Copper Letter, Sept. 16. (Copyright, 1911, by Dukelow & Walker Co.): "I figure that Utah Consolidated has ore profits in sight which are worth, together with its treasury surplus, at least two-thirds the present market value of its capital stock. The prospects of all the undeveloped western portion of its property, the bottom of the mine and the equipment, therefore, are selling for only a little over a million dollars. In view of this, and the fact that dividend payments are quite sure to be resumed in the near future, I feel that a fair price for the stock would be at least twice what it is selling for now.—Geo. L. Walker."

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The price of Utah Consolidated at the time mentioned above was $12.50 per share, two-thirds of which—the actual value—would be $8.16. A fair price, according to Walker's method of determining values, would therefore be $25 per share. Thus we have a very simple method of determining the price the public investor should pay for the shares of any particular stock. Easy is it not? Not long ago, when the same shares were selling at $80, Walker advised purchases up to $150.

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Apprehension has been expressed by timid people lest the Utah Copper Company should run short of cash to meet the cost of removing the capping from its orebodies. Such fears are evidently groundless, for the reason that the management still has authority to issue and offer for sale approximately 937,500 shares of treasury stock, about 76,000 shares of which are limited in price to $50 per share; but the balance may be sold at any price that may be deemed satisfactory to the management.

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On the surface a new steel gallows frame and a waste bin have been completed and machinery for timber framing put in place. Extensive cross-cutting and timbering is being done in 2090 tunnel.—Item from Ray, Arizona, concerning Ray Consolidated, in Boston Financial News, Sept. 12, 1911.

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The important feature of the foregoing bit of news is that in relation to the completion of the new "waste bin."

It is refreshing to know that the management of the property, "which is practically the same as that of the Utah Copper Company," recognizes the importance of saving the "waste" at the Ray. At the Utah Copper they scatter

the "waste" all over the country round about, just as though it was valueless.

****

Mount Aetna is throwing out more lava in a week than it did in a month during its former eruptions. Maybe it has caught up with the times and is using steam shovels.—Chicago Daily News, Sept. 19.

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It is evident, from the news contained in the above item, that the Chicago News has heard of Utah Copper, which is probably the only real rival that Aetna has.

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To the engineer of imagination the scene at Bingham at night, with the shovels at work beneath the glare of the searchlights placed upon the hills opposite is dramatic in the extreme; indeed, the whole work which D. C. Jackling and his associates have carried on is a striking example of creative imagination applied to engineering work.—Salt Lake Daily Tribune.

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CURTAILING PRODUCTION. — The Utah Copper Company, having completed Janney-izing six of the thirteen sections of its Arthur mill, and having run short of available cash, without encroaching upon the dividend fund, and at the same time being unable to secure the quantity of ore necessary to supply further increased milling capacity because of the lack of sufficient number of steam shovels to keep the capping removed in advance of the ore shovelers, discharged about 450 men and suspended indefinitely all work of construction on the remaining sections of that plant, thereby evidencing their proverbial good faith in observing last year's "gentlemen's agreement" to curtail production.

****

In the last Babson financial letter very favorable treatment is received at the hands of this prominent statistician by the Utah Copper and the Utah Consolidated companies of Bingham; also the Chino Copper company of New Mexico. Babson believes that these coppers are among the list mentioned that are deserving of consideration from an investment standpoint, and he believes that the time is here to lay in some of these copper issues, but according only to the Babson method. This method contemplates the purchase of twenty or thirty stocks instead of one or two.—Salt Lake Tribune, Sept. 1.

****

Some time ago Mines and Methods expressed the opinion that Babson had become attached to the Utah Copper's publicity staff and the foregoing reference to his work at least tends to strengthen that opinion. But, if Utah Copper and the other stocks mentioned are such good buys at prevailing prices, why should Mr. Babson advise the purchase of twenty or thirty other stocks at the same time? Does Babson also feel insecure in his evidently purchased expressions concerning "the world's greatest copper mine"?

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ADVANCED ENGINEERING THOUGHT—As early as 1908 Manager D. C. Jackling, in his annual report to the president of the Utah Copper Company—in his customary quiet and unassuming manner—gave utterance to the following brilliant thought: "There are some advantages in continuing underground mining in some portions of the property, because the ore mined in this way is taken from the orebodies lying directly beneath the capping, resulting in the capping caving into the open stopes and BREAKING ITSELF, so that it is not necessary to blast it for steam shoveling." Salt Lake Evening Telegram and Walker's Weekly Copper Letter will please copy and send bill to us.

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MIAMI.—The fine grinding in one-half of the fourth section is being done with an 8-foot Hardinge pebble mill instead of Chilean mills used in the first three sections. One Hardinge mill has been found capable of doing the same amount of work as a Chilean mill. The other two and one-half sections probably will be equipped with Hardinge mills.—Boston News Bureau.

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From Walker's Weekly Copper Letter, (Copyright, 1911, by Dukelow & Walker Co.): "When there comes to be a full public appreciation of the immense demonstrated value and earning capacity of the Utah Copper company its stock will be sought as an investment at prices ranging between $75 and $100 a share. At its present price it is one of the safest investments and surest speculations in the mining world.—Geo. L. Walker."

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The tenth annual edition of the Copper Handbook by Horace J. Stevens, of Houghton, Mich., is now being issued from the press. Eighteen months have been spent in an absolutely complete revision of the mine descriptions and statistical section of the book. The new edition, Vol. X, contains 1902 octavo pages of text, and lists and describes 8,130 mining companies, mines and so-called "mines," this being much the largest number of titles given in any work of reference on mines. As in preceding years, there are several hundred pages of preliminary chapters, devoted to the history, technology and uses of copper.

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The appearance of Mr. Stevens' latest volume will cause much speculation in copper mining circles. The boys will all want to see the book to learn just what sort of a "rating" or "berating" Mr. Stevens gives them.

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From an inside authority comes some interesting, though belated, information concerning the plans for a giant copper merger. This information is positive that the project is definitely shaped, but held up indefinitely. The plans for the merger, along the Steel Corporation lines, were perfected in New York some time before the Supreme Court decided the Standard Oil and Tobacco Trust cases. The full details and the papers in the merger were carried to Washington and submitted to Attorney General Wickersham and others in authority there, and were fully approved by the attorney general, but, on advice, the promoters withheld final action on the merger until the Supreme Court decided the Trust cases. When the decisions were handed down there was such a cry from the press, or one class of them, and from the public, that it was deemed unwise to spring another gigantic trust upon the public at that time. Washington advised against it, and suggested that the announcement be deferred until a more propitious time. Later politics came in, and Republican leaders prevailed on the copper men to hold off their merger until after the next Presidential election. And that, it is claimed, is the present status of the big copper merger.—Butte correspondent in London Mining Journal, August 28.

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Great preparations are evidently being made to work the English investors when the time is ripe. It is a "lost hope" of saddling off on to someone the big things in copper which are too good to keep.

Returns to the Ontario Bureau of Mines for the first six months of the current year are more than usually gratifying. Whilst the production of copper and nickel has fallen off, the output of silver is greater by 2,417,142 ounces than it was during the corresponding period last year. The amount of iron ore mined is 94,803 tons, or 55,306 tons in excess of the quantity mined during the former half of 1910. Gold once more appears on the list, 2,276 ounces having been extracted up to June 30th, 1911.—Canadian Mining Journal.

INFORMATION DEMANDED BY MINING INVESTORS

By AL H. MARTIN.

As the basic principles governing the mining industry become more intelligible to the investing public, the examining engineer's report occupies a position of ever-increasing importance. As in every other human industry, capital is required to win the golden rewards from the mines of the world. Consequently, the more intelligent the information diffused to inquirers, and the higher the knowledge possessed by the seeking individual, the more satisfactory will be eventual results. Legitimate mining offers opportunities for wealth possessed by few other lines of human endeavor, but the operations of fake promoters, and the gross ignorance displayed by hordes of so-called investors, has perhaps affected the mining world more seriously than any other pursuit. The mind of the average investor is fired by dreams of speedy and easily-acquired riches and in the mad scramble for wealth the ordinary precautions are totally disregarded. But slowly the great mass of the investing public is beginning to realized that mining is an industrial enterprise, and not the fabled wheel of Fortune. With this discovery has come the inevitable reaction, and hundreds of meritorious mines are lying inactive for lack of capital for their operation.

Accordingly the leaders of the mining world have come to realize that the public must be educated to understand the difference between legitimate mining and stock-gambling, also to distinguish the vast gulf existing between mining and prospecting. The average investor in the past has been influenced principally by the stock market, instead of by the physical worth of the property. Given a stock that displayed great animation on the Exchange the investor was satisfied, and scarcely a thought was given to ore reserves, management or the hundred and one other things that involve the development of a successful producer. Consequently heavy losses were generally incurred, and the misinformed buyer denounced the industry as an unmitigated swindle. Usually the fault has been his own, due to his lack of understanding; his failure to exercise ordinary precautions; his total disregard of all that is imperative in the selection of a desirable mine investment.

But with the new era has come a more perfect conception of the merits of the industry. And with this conception has developed a paramount interest in the report of the examining engineer. The intelligent investor no longer purchases stock in a company of which he knows nothing, and for preliminary information he turns to the engineer's statements. Consequently the report of the expert is attaining an importance that has attracted little attention in past years.

As the investor studies the report to gather information, it necessarily follows that such report should be sufficiently lucid and detailed to contain all the data possible. The investor is interested in the details, as he realizes the greater his knowledge of the property in question, the more likely is he to direct his steps aright. Every property of merit affords the examining engineer an ample field for the collection of data, and the report should be prepared in such a way that its analysis is readily feasible.

In analyzing a mine report, particular attention is devoted to the quantity and quality of the ore, as upon this resource depends the success or failure of the mine. But simply because a mine may have 100,000 tons of $10 ore is no guaranty of its dividend disbursing probabilities. If the ore is highly refractory, necessitating the employment of costly metallurgical processes; if power and labor costs are abnormally high; if transportation facilities are of such a nature that shipping costs are excessively costly, the mine may be practically valueless as far as future profits are concerned. Consequently the discriminating investor must take all these factors into consideration before arriving at a final decision. If the report does not contain these essentials, it remains for the prospective stock purchaser to secure them from other suorces, reports of the U. S. Geological Survey frequently affording the desired information. But when the report lacks the essential data, it is hardly probable that the proposition is as meritorious as its promoters would indicate. And in making this analysis it should be borne in mind that the future of the property from an assured standpoint depends absolutely on the developed orebodies, not on which may be later discovered in undeveloped territory.

Strictly speaking, a mining investment means the purchase of a developed mine in a proven district. When the property is a prospect the purchase naturally becomes speculative. Indications may be extremely encouraging, but the element of chance is so pronounced that the project ceases to bear the investment feature. Likewise any property in a new and unproven district is a speculative venture. Consequently the man desiring to make his mining investment a paying one, must confine himself exclusively to properties that are either paying profits, or are on the eve of doing so. And again, because a mine is paying profits at the present time is no warranty of its merit. The orebodies may be nearing exhaustion, or the veins passing into the territory of other owners. In some cases the prosperous mine of today may be the worked-out memory of tomorrow. In his analysis of the reports the prospective investor must take these points into consideration. Thus he must be familiar with the district and possess a good knowledge of the property which has excited his interest. In other words, in selecting mining investments he must exercise the same keen, trenchant judgment he would display in obtaining an interest in a manufacturing establishment, or in buying a home or piece of real estate. The sooner the fevered dreams of early riches are eliminated from the mind of the average mine investor, the sooner will the mining industry be realized for what it is—a sane and safe investment, with chances of great profits.

It is natural for any company to make the most of the good points of a property and pass lightly over the disadvantages. This rule is exercised every day in all lines of business. But it does not follow that the purchaser should close his eyes to these obvious facts. Accordingly, in his examination of reports he should cultivate an ability to read between the lines, to ferret out and study little items that are given scant attention. He should note whether values are improving or depreciating with depth; whether operating costs are increasing or decreasing. And always he should balance one point against another so as to gain a correct appraisement of the whole. Thus, while the value of the ore may show a falling off as depth is gained, the dimensions of the vein may be increasing sufficiently to offset the decreased worth. In one of the foremost of California gold mines the vein in the upper level averaged $25 per ton, while in the lower workings it runs $14 per ton. But in the upper workings the vein shows a width of only two feet while at depth it widened to six feet. And this was done

without any marked change in the character of the ore. Consequently, the property is disbursing profits from the lower-grade ore that were impossible from the higher-grade. It is a little point like this that must be duly considered in making the analysis.

In the case of a property that has been in operation for some years, the monthly statements of the manager, if sufficiently detailed, offer a rich and satisfactory field for analysis. By means of these the lowering or increase of the operating expenses, and the physical changes of the mine are easily followed. Coupling the information thus secured with the amount of the developed ore and other immediate data, the prospective investor has a fair knowledge of the property under consideration.

Through the columns of the mining press, and the reports of the various geological bodies, he is enabled to gather information relative to the geology of the district, and the character and value of the veins. This in itself is a point that often marks the line between success and failure. Finally, it must be remembered that a poor manager can easily ruin a good mine, while not even a sterling manager can transform a worthless prospect into a revenue producer.

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QUALITATIVE MINERAL TESTS

By A. L. SWEETSER.*

By the proper use of the blow pipe two very different chemical reactions take place in the ore under examination, namely, oxidation and reduction.

The oxidizing flame is produced by holding the jet of the blow pipe just above the wick of a candle, lamp or gas burner and inserting the same into the edge of the flame and blowing strongly and steadily. This makes a long, pointed blue flame, and the object to be tested is held beyond the point of the flame.

In the reducing flame the blow pipe is not inserted in the flame and the object tested is held in the yellow part of the flame.

All ores must, if possible, be reduced to a fine powder before a test can be attempted. A small quantity of this powder, mixed with a little sodium carbonate, is then placed in a slight cavity, on charcoal, of about one-half inch wide and of the same depth, and treated with the reducing flame. All odors and colors that appear while the substance is hot and when it is cold should be carefully noted.

The presence of arsenic is shown by a garlic odor, and the smell of sulphur denotes the presence of a sulphide. The character of the metallic globules of the reducible metals and the colors of the coatings on the charcoal are as follows:

		Coatings.	
	Globule.	Hot.	Cold.
Bismuth	Brittle	D'k O'ge	Lem. Yel.
Antimony	Brittle	White	White
Silver	Malleable	D'k Red.	White
Tin	Malleable	Pale Yel.	White
Lead		O'ge Yel.	Yellow
Zinc		Yellow	White
Cobalt		Red B'rn	Red B'rn

If the end of a platinum wire is bent into a loop, heated to redness in the oxidizing flame of a blow pipe and then dipped into some borax and reheated a clear borax bead will be formed. Such a bead, when dipped into powdered ore and heated, will show the presence of certain minerals by the colors imparted to the borax bead. The test should first be made in the oxidizing flame and then in the reducing flame, and the colors, both hot and cold, in each case should be carefully noted.

BORAX BEADS.

	Oxidizing Flame.	
	Hot.	Cold.
Copper	Green	Blue
Cobalt	Blue	Blue
Nickel	Violet	Red Br'n
Iron	Red	Yellow
Manganese	Violet	Amethyst
Molybdenum	Colorless	Colorless
Chromium	Green	Green
Uranium	Yellowish	Green
Vanadium	Colorless	Colorless

	Reducing Flame.	
	Hot.	Cold.
Copper	Colorless	Red
Cobalt	Blue	Blue
Nickel	Gray	Gray
Iron	D'k Green	D'k Green
Manganese	Colorless	Colorless
Molybdenum	Green	Green
Chromium	Green	Green
Uranium	Green	Green
Vanadium	Green	Green

For the benefit of those who are unable to acquire the habit of breathing through the nose while blowing through the mouth, without stopping, and also as a check on the blow-pipe results, the following liquid tests will prove of value. Unless otherwise stated, always use nitric acid to get an ore in solution after it has been powdered.

Silver—To the solution of the ore add a little hydrochloric acid. If a heavy, white, curdy, precipitate forms and this turns a dark color on exposing it to the sunlight, silver is present.

Gold—Make a mixture of one part nitric acid and three parts of hydrochloric acid and dissolve the ore. To this solution add some stannous chloride, and if a purple color is produced, gold is present.

Platinum—Dissolve the ore in a mixture like that used for gold and then add some more hydrochloric acid and evaporate the solution almost to dryness. Pour a little ammonium chloride and some alcohol on the above and a heavy yellow precipitate will indicate the presence of platinum.

Mercury—Stannous chloride added to a solution of the ore will yield a white precipitate of mercurous chloride.

Copper—Liquid ammonia added to the solution will give a deep blue color, which is the characteristic test for copper.

Lead—A deep yellow precipitate is formed on the addition of potassium dichromate.

Bismuth—To the solution add sulphuretted hydrogen and filter off the liquid. Dissolve the precipitate in nitric acid and boil it with ammonium carbonate. Then add sulphuric acid, and if bismuth is present potassium iodide will cause a dark brown color.

Arsenic and Antimony—Dissolve the substance in hydrochloric acid, evaporate almost to dryness and then add water and filter the solution into a platinum dish. In this dish place a piece of zinc. If arsenic is present it will be deposited on the zinc, and if antimony is in the solution the dish will be stained black.

Solutions of nickel are green; those of cobalt are pink.

Zinc—Add sodium hydrate to the solution and then filter. To the filtrate add ammonium sulphide and sulphuric acid and boil the mixture. If zinc is present potassium ferrocyanide will give a white precipitate when added to the hot mixture.

Tin—Dissolve the substance in the same mixture as required for gold and platinum and then add sulphuretted hydrogen. A yellow precipitate indicates the presence of tin.

Molybdenum—If a blue color that soon changes to brown appears on the addition of sulphuretted hydrogen to an ore solution, molybdenum is present.

Tellurium—Purple color when the ore is dissolved in strong sulphuric acid.

Titanium—Deep brown color on adding a mixture of hydrochloric acid and barium peroxide to an ore solution.

Tungsten—Dissolve in nitric acid and add hydrochloric acid and stannous chloride. If tungsten is present a deep blue color will form when this mixture is heated.

Vandadium—After dissolving the ore add liquid ammonia and sulphuretted hydrogen. The result may be a deep red color. Filter this and to the filtrate add hydrochloric acid, and if a brown precipitate is formed vanadium is present.

Uranium—A yellow color produced on the addition of liquid ammonia to a solution.

*Mining engineer, Denver, Colo., in Mining Science.

Mines and Methods

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CONTENTS:

Iron rails make better sluice riffles than any other material and are laid lengthwise on a 4 by 6 scantling. The gold settles admirably in the space between them.

Carbon monoxide, CO, is a product of the incomplete combustion of fuels containing carbon. It is very poisonous, small quantities when breathed producing death.

The application of the barometer for measuring altitudes depends upon the fact that the atmospheric pressure decreases as the altitude increases.

PRACTICAL HINTS ON ORE DRESSING

The somewhat recent development of fields of low-grade copper ores has greatly enlarged the demand for that class of ore-concentrating devices theretofore in use in the treatment of the finely divided portions of the mineral contents of ores of all classes which from times almost immemorial have been subjected to some form of hydrous concentration. And whilst these new developments have, either by accident, good fortune or otherwise, caused to appear upon the horizon of the so-called technical world, many aspirants for primigenial honors the appearance of the new ores was not attended with any new or vexing metallurgical or mechanical problems except alone such as naturally arise from a rapid increase of a very familiar commodity, which in this case has imposed no serious burdens upon our splendidly equipped machinery manufacturers.

The copper mineral contents of these ores occurs, almost exclusively, in small sharply-defined grains disseminated throughout an exceedingly soft and friable gangue-stone, or in thin hard plates and films occupying fracture-planes therein, and readily yields to slight pressure from any form of crushing device capable of reducing the mass to about thirty-mesh, standard wire screen, from which it will be seen that the entire product becomes of that class which is amenable to successful concentration only by some form of bumping or jerking table, or by the buddle, or some type of traveling belt, long in common use. Of course, in the preparation of any ore for concentration, whether a portion of the constituent mineral be massive, and susceptable of recovery in coarse particles by means of jigs, as in case of the older mines, or whether the entire mass as in case of these new ores, must be reduced to a consistency adapted to treatment only by tables or buddles, it is of the utmost importance that the crushing be done in such manner as to avoid as far as practicable the abrasion or destruction of the chrystaline or granular form of the mineral particles.

Owing to the comparative softness, friability and law of specific gravity of the rock-gangue of the new ores, recovery of the mineral contents presents far less difficulties than does the correspondingly fine pulp which results from reduction of the more massive sulphide ores of the older mines. So that, in selecting concentrating as well as crushing machinery for equipment of the new mines, it was only necessary to ascertain what type of machines were employed in any one of the standard concentrating mills in Montana, Idaho, Arizona, or in fact any locality where successful concentration was being conducted. No one need to have made a mistake in this respect because—if we except the Wilfley and kindred tables and certain unimportant modifications of the old Frue vanner—practically no important or material change or improvement had been made in crushing or concentrating machinery for thirty years.

Therefore, in view of these facts, the silly slush which from day to day has burdened a certain class of truckling publications during the last five or six years—whereby extraordinary genius, skill and foresight has been attributed to every act and movement of those individuals who have had the good fortune to become attached in a managerial or even subordinate capacity to any of these new enterprises—is but nauseous drivel. It is true, however, that these obsequious parasites, whilst acting as the paid servants of unscrupulous market fakirs have, by persistent subtle flattery so inflated the pliant egotism of the executive heads of some of these new enterprises as to render intelligent progress upon established lines impossible. They have been unconsciously placed upon a pedestal of scientific intuition which comprehends all essential knowledge of the art of ore dressing without having been subjected to the humiliation of having to inquire how others before them had proceeded in similar undertakings. What wonder, then, that millions of dollars should have been swallowed up in the construction of mills totally unadapted to the purpose designed, and that, immediately upon the completion

of each of these costly structures, the work of replacement and reconstruction should follow with such close step as to tread upon the heels of the workmen who had laid the foundations of the original structure. Usually the original machine was superceded by another less fitted for the duty required, but occasionally a step was unconsciously made in the direction of established practice. But just why one kind of a machine should produce better results than another in the stubborn process of ore concentration will probably NEVER BE KNOWN TO EVERYBODY and need not be discussed here. But there are certain elementary principles and fixed laws which prevail in any successful process of ore concentration which it would be well that every mechanical engineer should understand who undertakes to design or construct an ore concentrating mill. However, such knowledge is not so essential if the engineer has the sagacity and courage to restrain his pride and adopt the design of a first-class plant which is in successful operation. With a mill so constructed it is only necessary to employ a crew of men who have been seasoned in the practical work of operating similar machinery in a similar mill, care being taken to secure an intelligent foreman of experience in the work. Never employ a NEAR RELATIVE OR CHUM as superintendent of concentration because, in the first place, they will never learn the business and think they don't have to; and then you can't discharge them because they always have "something on you."

With appliances and methods which for many years have been in successful use in the older mines—as before indicated—the concentration of these new ores becomes at once extremely simple and a comparatively high recovery of the copper contents should be easily attained. And yet, owing to lack of experience and elementary knowledge of the basic principles upon which successful results depend, the operators in case of all of these new enterprises—with the possible exception of the Miami—have fallen far below results attained in the treatment of similar ores of the old-fashioned mines.

In the near future Mines and Methods will discuss the theory and principles of scientific and practical ore concentration, in which we shall take the position that screen sizing, as employed in general practice, is carried to harmful extent, and that water classification in any form is absolutely destructive of best economic results.

TRUTH IS FINALLY OUT

It will be recalled that a deal was consumated two months ago by which the American Smelting & Refining Company took over the smelter proposition under contract to build. There has been marked activity at Hayden ever since the A. S. & R. acquired the smelter concession. The site that had been laid out by the Ray Consolidated and partially graded, was slightly changed and men and teams and steam shovel are now being worked night and day excavating for the new site on the north side of the gulch, near the Ray Con. power house. Surrounding the works has risen a tent city within the past few weeks where the workmen are housed. Commodious office quarters have been opened up, the entire second hoor of the McIntyre store building being used. There are 200 teams, a steam shovel and near 300 men employed. —Arizona (Hayden) Copper Camp, Oct. 11, 1911.

Of course the publisher of the little paper at Hayden did not dream, when he published the above item of news, that he was the first to tell the truth about the progress that had been made in the building of the Ray Consolidated smelter. For many months last year and early in the present year the "market builders" for the Utah Copper, Ray and Chino companies, were working overtime telling of the big things that were doing in Ray Con. smelter construction. Finally they had to "back up," as the money was not forthcoming to build the plant. They squeezed out by announcing that the Guggenheims would take over the "partially completed smelter" and would "PAY BACK ALL THE MONEY THE RAY HAD INVESTED IN ITS CONSTRUCTION AND EQUIPMEN TO DATE."

Like everybody else, we had imbibed the impression that the Ray Consolidated had really undertaken the building of a smelter—and we even thought it must be well under way when its sale to the Guggenheims was made, something over two months ago. But, as disclosed in the item from the Ray paper, we were fooled again—and so has been the public. The smelter had not even been started and only a small amount of grading for the site had been done. The Guggenheim engineers at once decided to go on the opposite side of the gulch to prepare ground for the contemplated plant, and thus they helped to clinch Si. Eccle's declaration that D. C. Jackling is "one of the greatest and most competent engineers in this or any other country," for there is no doubt that Mr. Jackling as manager of the Ray Con., selected the original site for the new smelter.

"BEFORE AND AFTER"

The Utah Copper property was purchased about six years ago on a tonnage basis of 10,000,000 tons actually developed and 10,000,000 tons of probable ore, averaging about 2% copper, and the stock sold at 24 on this tonnage basis.

Today the company has 203,000,000 tons of reserves, the $7,000,000 cost of plants and equipment has already been paid back in dividends in three years, and with a present production rate of over 100,000,000 lb. copper per annum, and dividends of over $4,500,000 a year, the stock sells around 40.

Could anything be more dishonestly misleading than the paragraphs quoted above? They are taken from the News Letter, published by Thompson, Towle & Co., October 11. In the first place when Utah Copper was selling at $24 00, as stated, the company's capitalization was only 450,000 shares, and its indebtedness was insignificant by comparison. Today, with the stock selling around $41, there are 2,500,000 shares to conjur with —quite a difference when you come to think about it. At $24 the market value of the company's holdings was $10,800,000; at $41, the market value is $100,250,000. Had the capitalization remained at 450,000 shares the money now being disbursed as dividends would have yielded more than $12 per share per annum, instead of $3. This conclusion of course is based on the supposition that the company would have continued to maintain its widely-heralded position of a "self-contained manufacturing proposition" and have kept within reasonable bounds in the matter of financing.

But there is where one feature of the company's campaign of deception crops out. At the time its management was most glib in recital of the "self-contained manufacturing proposition" idea it was practically at the end of its rope, so far as steam shovel operations were concerned, and this magazine called attention to the fact that inside of three years, unless the company secured additional ground, it would necessarily have to cease operations—through the plan inaugurated—for lack of available ore. Inside of six months—not three years—the company proceeded to show the falsity of the declarations it had made by opening negotiations for the purchase of Boston Consolidated and soon thereafter the deal was closed. That transaction substantiated our claim and left the management in an equivocal position insofar as its being able to convince the investing public of its honesty of purpose was concerned.

About the same time this magazine took up other features of the company's campaign of deception. It showed with what utter recklessness of cost, lack of care and disregard of established practice in the construction, equipment and methods applied to recover the copper from its low-grade ores, the company was proceeding. And every claim and charge along these lines that has been made has been verified times without number by facts and figures that the company has never disputed or challenged.

But we have told all these things so many times, and we have more recently so clearly shown into what financial straits the company has drifted, that it is hard to believe that the investing—or even the speculative—world will be led into the trap that has been baited for them by the hired press and brokerage representatives of the pooled interests crowd that is only waiting the chance to let the public "hold the sack" while they "cash in;" because, to assume for a monment that representations heretofore and now being made in respect to the value of this property, are true, is to assume that the owners and managers of this professedly-great mine are a band of lunatics, seeking to dispose of tremendously valuable assets at a mere tithe of their worth.

THE ABSURDITY OF IT

The Salt Lake Eevening Telegram tries awfully hard to keep saying things that will please the Utah Copper and other "new porphyries" managers. In its anxiety to prove its loyalty "to the cause," it frequently makes a spectacle of itself. On the 12th of the present month it had two articles—original or pilfered—in the same column from which the following brief quotations are made:

Sherwood Aldrich, president of the Ray Consolidated Copper Company, is scheduled to reach here about October 23, and in company with General Manager D. C. Jackling he will make a trip to the company's properties in Arizona.

A supporting factor in the copper metal market situation has come to light since the first of the month. The supposition has been that with the new porphyries coming in there would be a greatly increased supply of the metal, and contrary to this_view it has been demonstrated that it will be some time before these new properties reach the point where they will become an important factor in the metal production of the world.

Ray's new mill is easily handling all the mine product at this time, and the management is very much pleased with results obtained, which is now showing a considerable profit on operations.

This gives some idea of the ultimate capacity of the mill plant, as the four sections now in operations are treat... close to an average of 900 tons daily.

At times a high grade run will be put through, and naturally a large percentage of recoveries will be shown in the concentrates.

Within less than a year it seems highly probable that the directors of this company will be considering the proposition of paying dividends.

The three more important mines which are figured on increasing the supply of copper metal are Ray, Miami and Chino. Miami is not expected to produce more than two-thirds of its ultimate output; Ray may not make more than three-eighths of its capacity and Chino is just getting its new plant into commission and will hardly output more than one-third of its capacity for some time.

While these mines have been expected to reach a minimum output of 170,000,000 pounds of copper during 1912, it seems now probable that they will fall far short of that quantity.

And as Brother Higgins, of the Salt Lake Mining Review, would say: "And there you are; and then some."

WALKER MAKES DENIAL

To the Editor of Mines and Methods,
Salt Lake City, Utah.

Sir: In the September issue of Mines and Methods I find the following statement:

"When we come to consider that Mr. Walker's writings during the last few years have enabled him to accumulate several millions of dollars, one can form some idea of the value or cost of the foregoing to the Utah company; but perhaps a more correct conclusion in respect thereto may be found from the following, which is related by a newspaper man of this city: 'It appears that during Mr. Walker's last annual swing around the circle of Western contributing mines he prepared and published a highly complimentary description of the property of the Mason Valley Copper company's mines at Yerington, Nevada. This happened at a time when that company was offering for sale an issue of bonds for the purpose of securing funds with which to equip their property with a smelter. In recognition of the aid rendered by Mr. Walker, it was said that the company promptly sent him a check for $1,500, which he as promptly returned with the remark that the write-up was worth to the Mason Valley Company $5,000. Whether that amount was paid or not our informant was not advised, but we note that Mr. Walker's report on Mason Valley for this year is even more favorable than the last, and therefore it may be inferred the estimated value of the precious send-off was paid.'"

There is not one iota of truth in your statement. If you will prove that I was either offered or accepted $1,500 or $5,000, or received and accepted or refused a check for any other amount, I will give $5,000 to any Salt Lake City charity you may select.

You will confer a favor if you will publish this letter in your forthcoming issue. GEO. L. WALKER.

Boston, Mass., October 20, 1911.

THE COPPER SITUATION

The New York correspondent of the Mining and Scientific Press (Oct. 21) comments entertainingly—and with evident understanding—on the copper situation as follows.

"Copper producers in general appear to be tightening belts and preparing for a further indefinite period of low prices and decreased consumption. Unsettled conditions abroad must cut down the real export demand, and, while it is said on all sides that stockyards are as bare as they can be so long as business continues at all, yet there is no incentive, either in general business conditions or in the copper situation itself, to induce consumers to take on copper. * * *

"Some of the market developments of the week have been aptly illustrative of the absence of public interest. Tuolumne failed to declare its regular quarterly dividend since which announcement the shares have been advanced and the market held apparently strong, mostly because there was no attempt by the public to make market capital out of the cessation of dividends. Another instance was the advance in Chino and in Ray Consolidated immediately upon the appearance of the monthly figures of the Producers' Association. In neither case was market action logical, nor would it in either case have been possible with a public in the market."

TECHNICAL PUBLICATIONS

So many weekly, fortnightly, and monthly periodicals are published nowadays which contain articles of importance to the mining fraternity, that it is quite out of the question for an individual to regularly subscribe to all of them, or even to more than glance through the files when a fairly complete library is available.

To obviate this difficulty the Engineering indices which appear in Engineering & Mining Journal, Mining & Engineering World, and Engineering Magazine are of great assistance, especially to the engineer so situated that technical libraries are out of reach. The Engineering Magazine alone regularly reviews and indexes monthly the contents of 173 publications, which does not include those devoted to geology and ore-deposits.

The Geologisches Zentralblatt, appearing fortnightly, contains abstracts of leading articles from publications in many languages, translated into German, French, English or Italian. Even articles appearing in the Russian language are reviewed, and at a glance one is able to see what of importance has recently come out, (on the subject of economic geology, for instance), in every land.

These indices make it unnecessary to subscribe regularly to a large number of technical publications, because with their help the marooned engineer is able to locate and acquire immediately any articles of special interest to himself. What is of importance to one reader may be of minor interest to another, and at the present day when technical matters are so highly specialized it is impossible that articles of permanent value should be confined to a limited group of publications or to any one language. Many will of necessity seek the light along lines of least resistance, and only through technical indices become known to engineers to whom they may be of interest.

No one can feel sure that he is posted on any particular subject until he has looked through the technical indices mentioned, and has ascertained what has

recently appeared under that heading. When an engineer neglects this precaution the complaint is unwarranted that he was uninformed because some article came out in what he is pleased to term a "backwoods magazine." Such an individual, if he inspects the lists regularly reviewed by prominent technical publications, will probably find many that are to him of the backwoods variety, but not necessarily so to others.

A plan that works well is to keep a small deposit with some house that makes a specialty of technical publications, so as to be able to send a post-card order for any desired book or periodical as soon as notice of it has been received. One engineer of our acquaintance has had dealings of this kind with a Leipzig house (Th. Stauffer, Universitaetsstrasse 26, Leipzig, Germany) for over thirty years.

MEETING OF A. I. OF M. I.

(Excerpts from Mining & Scientific Press Report.)

The San Francisco meeting of the American Institute of Mining Engineers was opened Tuesday morning, October 10, with an informal reception to the visiting delegates in the Red room of the St. Francis hotel. In the evening the Sierra Madre Club members were hosts at a cleverly appointed dinner in their clubrooms at 313 West Third street. The spirit of the occasion was well borne out by the invitation cards, a reproduction of a placard announcing, in straggling letters.

"NOTICE.

"This is the Camp of The Sierra Madre Club. It is Open to all Mining Men & Prospectors. The Flour and Bacon are cached on the Roof and the Water Hole is just back of the Cabin. Let Those who pass on this Trail help themselves."

Below was inscribed a further greeting and welcome to the members of the Institute by the Sierra Madre Club.

The evening, however, was not wholly devoted to merely lighter matters, and a lecture on the Los Angeles aqueduct by William Mulholland, chief engineer in charge of the project, was both interesting and instructive. The lecture was illustrated with many lantern slides showing different features of the work.

On Friday, October 6, the delegates were guests on an extended trip to points of interest near Los Angeles. The oil-fields, the Soldiers' Home, the Redondo power house of the Pacific Light & Power Co., and the pleasure resorts at the famous beaches clustering about the city were some of the places visited. The trip was in charge of B. L. Dowell, traveling passenger agent of the Pacific Electric Railway company. The dinner was served in the unique "fish restaurant" of Hopburn & Terry at Redondo.

The first business session of the San Francisco meeting was called to order Tuesday afternoon, October 10. W. C. Ralston, as chairman of the local committee, in a few well chosen words welcomed the visitors, for whom Robert W. Hunt, vice-president of the Institute, responded happily in a short speech. The first official act of the delegates was the despatch of a telegram to President Kirchhoff expressing their regret at his absence, and their sympathy in his trouble, with their hopes for the prompt recovery of his mother, whose illness prevented Mr. Kirchhoff from attending the meeting.

The first paper read at the meeting, presented by E. B. Durham, was a well-prepared description of the electrolytic refining methods used in the United States Mint at San Francisco. This was followed by a paper by Bernard McDonald, who in his account of the "Parral Tank System of Agitation," gave a particularly interesting description of the improvements in practice he had worked out in the Mexican mills recently erected under his direction.

The geology, equipment, and method of working at Newport iron mine, Ironwood. Michigan, was described by B. W. Vallat. At this mine the sub-slicing system of mining is employed and in 307 working days in 1910 a total of 1,074,800 tons was hoisted through one shaft, an average of 3500 tons per day. The highest record was 6652 tons in one day, the average hoisting distance being 2150 ft., the maximum hoisting speed being 2200 ft. per minute, and the production was secured from four different levels. In discussion of this paper Gardner F. Williams called attention to the similarity of the mining system to that adopted at the Kimberley mine in South Africa in 1887, though at the latter no timber is used to form the top mat. The upper slice is caved as at the Newport mine, but the waste follows the ore directly. At Kimberley the hoisting is all done from one level, the material being dropped through winzes as much as 500 ft. to reach that level. There are two 10-ton skips for hoisting, these being run in balance. In separate compartments are cages for handling the 4000 natives employed. On August 4, 8514 tons were hoisted in 12 hours from the 100-ft. level, and August 11, 9098 tons. The highest previous record was 8433. In six days 48,000 tons has been hoisted. Material is brought to the loading station in one-ton cars hauled by an electric locomotive. The cars are dumped by the natives and trains of 32 cars have been handled without stopping the train which moves slowly over the bin.

In his treatise on the "Electro Deposition of Gold and Silver from Cyanide Solution," S. B. Christy gave a scholarly review of the work of the last dozen years on this highly technical subject. The paper contained much interesting material, but too complex to be summarized in the space available in this issue.

The technical session on Wednesday morning was opened by an intensely interesting paper on "California Oil," by Mark L. Requa, to which the secretary emeritus, Dr. Raymond, added pertinent and interesting discussion in which several other members joined. A representative of the Panama-Pacific Exposition welcomed the members of the Institute to San Francisco and requested their aid in making the forthcoming exposition a success. Tre papers on dredging by Messrs. Charles Janin and Francis J. Dennis were read by Mr. Dennis in the absence of Mr. Janin, and a brief discussion of dredging problems followed. This was followed by an interesting paper on the gold production of California, by Charles G. Yale, who has been so closely identified with the development of the mineral industry of California, and many of the members joined in the discussion which followed.

The secretary read a telegram announcing that a research scholarship would be established at Columbia University as a memorial to Sameul Franklin Emmons, as noted in the editorial pages of this issue. E. H. Benjamin announced that A. D. Foote, whom it was hoped would be present at the meeting, was undergoing a serious operation, and a resolution expressing the hopes of the members present for his safe and speedy recovery was unanimously carried. The morning session was brought to a close by an informal talk by Thomas T. Read on the mineral industry of China, illustrated by lantern slides, which aroused much interest.

At 2 p. m. Wednesday afternoon the party left the City by special train for a trip down the peninsula and a visit to Stanford University. At Palo Alto they were met by the Stanford members of the Institute and the students in mining, and taken by special cars and autos across the beautiful campus of the University. The shops, laboratories, libraries, and museums were inspected, after which on the roomy porches of the Delta Upsilon house the visitors were served light refreshment and informally met the men of the departments related to mining.

In a paper on the "Fritz Engineering and the Coxe Mining Laboratories of Lehigh University," Joseph Daniels, associate professor of mining engineering in that institution on Thursday morning told of the founding and equipment of the two laboratories. He remarked that the new ore-dressing laboratories of Lehigh are in the natue of a new departure, as, on account of its proximity to the Pennsylvania coalfields, the principal interest of the university has been in coal mining. With the new facilities it has been found that in spite of the fact that 90% of the students are drawn from coal-mining districts, only 10% of the students after graduation return to the coal-mining industry, the majority preferring metalliferous mining. R. W. Hunt, who was chairman, spoke at the dedication of the Fritz laboratory, remarked Mr. Daniels. In this laboratory, tests were made of concrete material, for the city of Scranton, and it is proposed to provide facilities for testing road material.

In a technical but intensely interesting paper on "Slime-Filtration,' George J. Young, professor of mining and metallurgy in the Mackay School of Mines, told of the data he had collected.

Reiji Kanda, a consulting engineer of Tokyo, a member of the American Institute of Mining Engineers, arrived on the Chiyo Maru on Thursday and spoke at the session as a representative of the Mine Owners' Association of Japan. He bespoke a warm welcome for the American engineers on their coming trip, in which he will act as escort.

A paper by H. Foster Bain, in which he advocated the leasing system of the Alaska coal-lands, and the opening of one mine by the Government, aroused some of the keenest discussion of the Institution. J. W. Malcolmson asked why it would not be advisable to permit the development of Alaska on the individualistic lines which existed during the development of the West. Mr. Bain pointed out some differences in the two problems and asserted that the men most interested in the coal-lands of Alaska were not residents there throughout the year. Edward W. Parker gave some interesting statistics regarding the consumption of coal in the United States and the production of coal in Alaska.

Dr. R. W. Raymond, who was acting as chairman, strongly disapproved of the course advocated by Mr. Bain. He affirmed that the United States Government is not capable of conducting the fuel business with the same certainty of method as private individuals, and said that the Government has no maps which show the mineral land still the property of the United States. The aim of the Government, he continued, has been to give every man a chance to own 160 acres of coal land, and not to interfere with his disposal of the land. But the Government lately has undertaken to add commandments to the decalogue, and to create crimes for which none need blush because denounced by some demagogic reformer. The United States, he asserted, in regard to the Cunningham claims, failed in its trust in not granting title to the claims. The main feature of the new law, he said, had been disregarded, in that stockholders in one coal company could not hold stock in a rival company. In the future some "Glavis Junior" might discover such ownership and associated stockholders would lose without appeal title in the lands. Federal taxation of any natural resources would subject citizens utilizing the resources to a handicap not experienced by the citizens of Texas, where the State of Texas and not the United States has control of natural resources. The people of the United States are drifting into a policy of opportunism, and the multiplicity of laws has made it impossible for industrious and ambitious citizens to know whether or not they are criminals under the law. We now have a lot of impossible cures for imaginary evils through recent legislation in individual States, but such legislation at least indicates that individual States can be persuaded to remedy evils, while it would be impossible to get a majority of the States to agree on any change in the Federal policy. Mr. Raymond's speech was interspersed with witty stories, and was greeted with applause.

Thursday afternoon the delegates visited the University of California. Dr. Raymond gave in the Greek theatre some "Reminiscences of the Beginning of the Institute," and G. T. Becker gave a biographical notice of S. F. Emmons.

On Friday many of the delegates went on an excursion to the gold dredges at Natoma. There they were entertained at a pleasant luncheon by the Natomas Consolidated company. After luncheon the dredges were visited and the rock-crushing plant at Fair Oaks inspected. On the return the delegates were guests at dinner of the San Francisco committee in the dining-car. Many of the ladies and delegates as well were visitors to many factories about the bay, where a cordial welcome was given them.

On Saturday afternoon the delegates left the St. Francis hotel at 1:30 p. m. in special sightseeing automobiles for a three-hour trip, stopping at Golden Gate Park to witness the ground-breaking ceremonies for the Panama-Pacific International Exposition in 1915.

On Sunday the members of the Institute and their guests, to the number of about 200, made an excursion to the Bohemian Grove, on Russian river in Sonoma county. After an hour spent in strolling about the grove, lunch was served, followed by an hour of music in the leafy amphitheatre.

On Monday evening the local members of the Mining and Metallurgical Society entertained the visiting members and prominent members of the Institute at a dinner at the Fairmont hotel. The dinner was followed by a discussion of the Alaska land laws, which was opened by H. Foster Bain, and in which Dr. Raymond, George Otis Smith, E. W. Parker, W. R. Ingalls, Charles G. Yale, M. L. Requa, W. C. Ralston, and W. L. Saunders joined.

On Tuesday morning, Oct. 17, the members of the Institute who are to visit Japan sailed on the SS. Manchuria, to return early in December, Joseph Struthers, the secretary, being in charge of the party, which is accompanied by Reiji Kanda, who came to San Francisco as the representative of the Japanese mine owners' association.

OPENING MINE LEVELS

It is now considered good practice to open mine levels 150 ft. apart, the distance being measured on the vein. In earlier years the distance seldom exceeded 100 ft. and was often less, but where the vein is found to be persistent in depth it has been found less expensive to increase the distance between the levels, the economy being in the saving of the increased cost of driving the levels at more frequent intervals, timbering them where necessary, and also the cost of the more frequent cutting and equipment of stations, where the mine is operated through a shaft. These are all more expensive than stoping.

It is obviously less expensive to open and equip eight levels than twelve, in going down a distance of 1200 ft. At one time the objection was urged that great distance between levels resulted in a greater expense in cribbing and keeping the mill-holes in repair, as the timbers of the cribbing would be completely worn out by the falling rock, and these had to be replaced at considerable expense and loss of time in the consequent interruption of the work, not to mention the danger to the men. Shrinkage stoping has largely remedied this difficulty and levels may now be 200 ft. apart as well as less.

Black powder is exploded by combustion, while dynamites must be detonated.

THE ELIMINATION OF OIL FROM RETURN FEED WATER

By C. E. CROCKER.*

It is well known that any considerable amount of oil allowed to enter boilers with return feed-water is dangerous and destructive to the tubes and plates, but it is not perhaps so generally realized that oil is destructive even if admitted in very small quantities, and, by accumulating on the heating surfaces, it greatly reduces the efficiency of evaporation. It has been determined that the transmission of heat through a boiler-plate will be retarded more by a film of grease 0.001-in. thick than by ⅛-in. of scale. The oil also assists other deposits from the water to adhere to the surfaces, and necessitates more frequent cleaning. In most cases the cost of removing the oil before the water enters the boiler will be more than saved by the reduction in boiler-cleaning expense; but even if this is not so, the treatment is justified by the better evaporation obtained and the protection it gives the boiler.

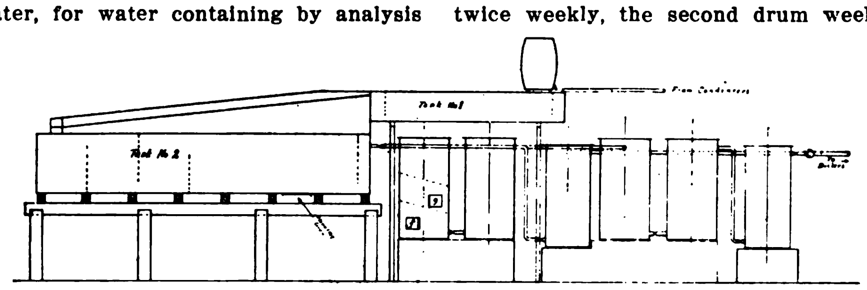
Most of the free oil present in exhaust steam can be removed by one of the types of mechanical separators on the market; or where jet condensers are in use, the oil will float on the water in the tail pit or tanks and may be skimmed off, but that part of the oil that becomes emulsified and gives the water a milky appearance is more difficult to deal with, and cannot be separated even by passing through filter-paper. It is necessary to treat the water chemically, or otherwise to cause the oil to coagulate before it can be separated by filtration.

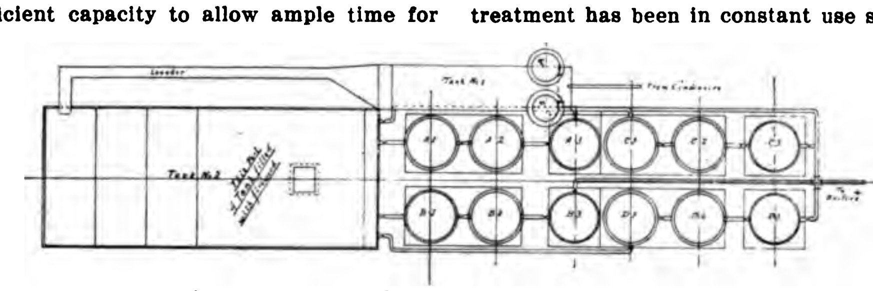
At the plant of the Kalgoorlie Electric Power and Lighting Corporation, Limited, several methods and arrangements of filters were tried, but they were found to be either ineffective or unworkable, on account of difficulties in dealing with the filters. An electrical method, which consisted of passing the oily water through a tank containing iron plates as electrodes, and submitting it to an electrical current equal to about 1.1 kilowatts per 1,000 gallons, was very effective in causing the oil to coagulate, but it had to be abandoned owing to the corrosion set up in the feed pipes and in parts of the boilers. This appeared to be due to electrolysis, although every care was taken to insulate the electrical portion from pipes, etc.

*In Monthly Journal, Chamber of Mines Western Australia.

The treatment now in use has proved to be very effective and cheap in working, and although it is not considered in any way novel, a description of it may be of interest to others who have similar conditions to contend with. The method consists of treating the oily water with alum and common soda in the proportions of approximately 0.35 lb. of alum and 0.30 lb. of soda per 1,000 gallons of water, for water containing by analysis 3.5 grains of oil per gallon of water. The quantities of chemicals would, of course, be varied to suit the amount of oil contained in the water. The apparatus employed in the treatment should have sufficient capacity to allow ample time for the chemicals to act on the oil. In the plant referred to about 50,000 gallons per 24 hours are treated. The capacity of the tanks and filters is such that five hours are required for the water to pass through. A longer time would probably be an advantage, and would reduce the consumption of alum and soda. As the precipitant formed is very light and easily broken up, it is desirable that the plant should be so arranged as to reduce the agitation of the water, as much as possible, in its passage through the tanks.

The alum and soda are each dissolved in the barrels A and S respectively, and the solutions are allowed to drip from the barrels and mix with the incoming greasy water in Tank 1. The water passes under and over baffles in Tank 1 an 2, and through a quantity of rough filtering material or firewood in part of Tank 2. Each of the drums in the four sets of filters, A, B, C and D, contains a bed of filtering material between the perforated trays indicated by dotted lines on one of the drums. This filtering material may be coke, charcoal, wood-wool, shavings, or any fairly open or porous bed. Sand is most effective, but clogs up too quickly to be used in the plant mentioned. The Tank 2 has a cleaning door in the bottom, through which, after the water is drained off, the accumulation can be discharged. This tank requires cleaning monthly. The filter-drums are provided with drains and cleaning-doors, through which the filter-bed can be quickly removed and renewed. The first drum in each set is cleaned twice weekly, the second drum weekly, and the third fortnightly. On entering the apparatus the water contains 3,500 grains, and on leaving 850 grains of oil per 1,000 gallons. The cost of chemicals amounts to 1.15d. per 1,000 gallons. The treatment has been in constant use some two years with satisfactory results, and the boilers are in excellent condition, requiring considerably less frequent cleaning than they did formerly.





Apparatus for Eliminating Oil from Return Feed Water—Elevation and Plan

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The theoretic percentage of metallic copper contained in the various principal ores of copper, when pure, is as follows:

	%
Cuprite (red oxide)	88
Chalcocite (copper glance)	78
Malachite (green carbonate)	62
Azurite (blue carbonate)	61
Bornite (peacock sulphide)	58
Chalcopyrite (copper pyrite)	34

Official figures show the value of silver, silver lead, zinc concentrates, copper, tin, and coal exported from New South Wales during the first half of this year to have been £3,659,166, showing a net increase of £579,169 compared with the corresponding period of last year.

COPPERETTES

It is stated in the east that a pool composed of southern bankers has been formed to finance the cotton crop and it is suggested by the Pittsburg Gazette Times that this means to hold the crop until 13 cents can be secured. If such a financial measure is possible in cotton, why not in copper also?—Exchange.

* * *

A bright idea; why not? For additional information consult one Secretan.

* * *

Nothing is quite so characteristic of the writings of Horace J. Stevens as the manner in which he compels the word "circa" to do overtime. He makes it stand for just "about" everything that is inaccurate or "approximate" in his Copper Hand Book, and which he does not personally care to "stand for." There fore we should say that, had he been less biased or "boodled" in his nearly nine pages of Tom Lawson-George L. Walker "market letter" material concerning Utah Copper, the investing public might have been disposed to agree with "circa" all that was said. As the story looks and reads it is quite evident that "circa" all the data, as well as much, if not "circa" all the language of the recital, was supplied by the Utah Copper Company's own publicity bureau. But then—it costs money to issue works like the Copper Hand Book.

* * *

The Boston Financial News of the 17th instant says: "Bingham—Shipments amounting to 11,000 tons a day are now going forward over the Bingham & Garfield, the new Utah Copper railroad from this camp to the smelter at Garfield. The Denver & Rio Grande is carrying 7,500 tons also, a total of 17,500 (18,500) tons. The Utah Copper today is making the heaviest ore shipments in the history of the company."

On the same day, Oct. 17, Thompson, Towle & Co., in their News Letter, said: "We are in receipt of advices from the west stating that the Utah Copper Company is now shipping to its concentrators 15,000 tons of ore daily, one third of which is going over the company's new Bingham & Garfield railroad."

Mr W. B. Thompson, senior member of the firm of Thompson, Towle & Co., is a member of the Utah directorate and reputed large holder of pooled shares, and therefore no doubt receives his information from first hands, whereas the Financial News, like other members of the publicity bureau, must print whatever is supplied to it by the local office. Readers will, of course, take their choice, but we suggest that any one doubting the accuracy of the higher figures will be regarded as a "knocker."

* * *

"I figure that the world's output will increase about 8 per cent in 1912 over 1911, 5 per cent more in 1913, and not over 2 per cent annually in 1914, 1915, and 1916. If consumption increases again as it did from 1901 till 1906 copper may sell at 30 cents or higher in 1915 or 1916.—Geo. L. Walker's Weekly Copper Letter. (Copyright by Dukelow & Walker.) Cable address, "Dukelow," etc.

* * *

This carries the inference that the public should get into the Copper shares without delay. Walker is evidently trying to wear the hot-air pumps discarded by Tom Lawson, but he is yet a little timid and uncertain in his stride. To "figure" copper at 30c. a pound five years hence certainly gives the public ample time in which to forget just what Mr. Walker has said.

* * *

A great service has been rendered legitimate mining industry by J. R. Finlay through his disinterested report on the actual worth of individual Lake Superior mines. The value of this report lies in the fact that it was made by an experienced engineer to the Board of State Tax Commissioners of Michigan, and deals with facts: it can very well serve as a type of report which investors in mining stocks should insist upon having from mining districts.

* * *

Of course, many holders of stocks issued by Lake Superior mining corporations resent having the truth told about the particular properties in which they are interested, and publicly voice their dissatisfaction. This was to be expected: no one likes to be told that he has been separated from his money through the machinations of clever promoters But then there has to be an awakening from roseate dreams sometime!

* * *

If during the period of sixteen months, which elapsed from the close of its fiscal year 1909, to the date of issue of its annual report for 1910, the Utah Copper Company had actually developed—as shown by that report—over a hundred and ten million tons of ore, the existence of which was theretofore unknown to the shareholders, and which newly discovered ore was—according to its own rating—of the value of nearly a hundred million of dollars; and if, during the period in which this stupendous development was being made, all knowledge of the fact was carefully concealed from the public and the small shareholders until practically the entire capital stock issue had been gathered up by the inside or pooled interests, as stated by this journal at the time, what assurance can present investors have, that, as soon as the holdings of the insiders are unloaded on the public, the entire alleged supply of ore may not as suddenly disappear, or cease to yield profitable returns until such time as the insiders may again gather in the floating shares at greatly reduced prices, and so continue to repeat the process ad infinitum?

* * *

"Mines and Methods," pulished in Salt Lake City, comes to us without one single advertisement. It states that its criticism of the Utah Copper Company has caused that concern to go after its patrons and force them to withdraw their patronage.—Los Angeles Mining Review.

* * *

Yep! And we are not going to file a petition in bankruptcy, either.

* * *

The Mining & Scientific Press is irritable because Mines and Methods presumes to present its readers with high class technical information and at the same time boldly criticise the methods of those who pose for pelf as great engineers, mine managers and metallurgists. All we can say in reply at this time is: "Don't worry yourself sick on our account, dear old Sister Press; everything will come out right in the end. "For our part," we must insist on presenting information on subjects that interest and concern our readers in our own way. When we get ready to do things in the old, stereotyped fashion followed by the Mining and Scientific Press and other self-styled 'technical' . journals, we'll call in a new doctor."

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There has been no denial of the statement published in the last issue of Mines and Methods, "that the closing down of the work of enlarging the Arthur plant of the Utah Copper Company, after completing only six of the thirteen sections, was due entirely to lack of funds with which to continue the work." We therefore call the attention of Walker's Weekly Copper Letter to this trivial omission. It will be remembered that all work of reconstruction of the Arthur plant, as indicated above, was suspended about

September 15th and that the manager explained shortly thereafter in effect "that the work would not be resumed during the winter months or until the supply of available ore should render increased milling capacity necessary." Perhaps this explanation makes it unnecessary to undertake to show the presence of a large surplus where none exists.

* * *

Complaints are appearing in the press that while Utah Copper and Ray Consolidated Copper shares have been marked down fifty per cent, still the public is taking them very sparingly. We would respectfully suggest to the sales-agents of the syndicates that perhaps the servant girl class would become more interested in their wares if they were advertised for sale on easy payments. Might try five per cent down and fifty cents per month until paid for.

* * *

It is not a popular occupation—telling the truth about mining schemes. It arouses in particular the enmity of wealthy promoters, and of sales-agents employed to distribute their engraved share-certificates of incorporated dreams. There is more pecuniary profit in assuming the role of promoting-engineer, and in assisting the distribution of stock through getting interviewed by newspaper reporters, and in other ways. For this reason the position taken by Mr. Finlay will meet with approbation by honest men generally.

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It is said that at the great packing houses in Chicago there are animals which lead an easy existance by acting as decoys for their fellows, cheerfully heading the procession destined for slaughter, but effecting their own escape at the proper moment. Such conduct is not pleasing even in the lower animals: what can be said about human animals, who knowing better themselves, publicly boost the sale of engravings which represent fictitious values (at the price asked)? Mr. Finlay, through his report on the Michigan mines, demonstrates that he occupies a position over and against the decoys.

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Mr. Finlay says: "Stock-market valuations are not considered. It will be observed that this method (of computing worth of properties) makes no mention of quoted values. * * * Mining stocks do not represent anything definite. Some pay dividends, in which case their quotations are comparable with those of other securities, but in the majority of cases mining stocks represent nothing more tangible than hopes." Then continuing, and possibly having in mind some of the porphyry coppers, Mr. Finlay's report reads: "Still it is doubtful if much of these stocks is sold to a gullible public. They are mainly bought and sold by seasoned gamblers with whom it is a case of "dog eat dog' ".

* * *

"The placing in commission of the (Utah Copper) company's railroad comes at a very opportune time, as the work of enlarging the concentrator has proceeded to such an extent that an increased tonnage can now be handled, and this tonnage transported over the company's lines, thereby resulting in a considerable saving in freight."

"Under the new contract of the Utah Copper Company with the D. & R. G. W. Ry., 7,500 tons (daily) will be hauled by that line. Any tonnage OVER AND ABOVE this amount will be handled by their own railroad. The additional equipment and rolling stock which has been ordered for the new line should be at the property in sixty to ninety days, at which time the company will be in a position to handle any tonage required by the concentrator."—Thompson, Towle & Co. News Letter, Oct. 17, 1911.

At the present claimed rate of shipment of ore from the Utah company's mines—15,000 tons a day—the new Bingham & Garfield railroad would have available for haulage 7,500 tons per day, upon which there would be a possible profit, according to official estimate, of 8 cents per ton or $600 per day, and $219,000 per year. The cost of the road and equipment is conceded to be in excess of five million dollars, the annual interest on which, at six per cent, will amount to $300,000, being $81,000 per annum in excess of net earnings. It is hoped, however, that the prestige of owning its own railroad will more than compensate this apparent loss by the impetus it will afford manipulation of the share market.

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UTAH INCREASES COAL OUTPUT

The value at the mines of Utah's coal production in 1910 was $4,224,556, with an output of 2,517,809 short tons, according to E. W. Parker, of the United States Geological Survey.

Compared with 1909, when the coal production of Utah amounted to 2,266,-899 short tons, valued at $3,751,810, the output in 1910 showed an increase of 250,910 short tons, or 11.07 per cent, in quantity, and of $472,746, or 12.6 per cent, in value. Utah's production in 1910 was affected only indirectly, if at all, by the coal strike in the Middle West—that is, by the demand created on the mines of Colorado and New Mexico, which possibly reduced the competition of coals from those States in markets to the west and southwest reached jointly by them and the coals from Utah mines. This increased production of Utah coals is looked upon as only an indication of normal growth that may be expected to continue as the country develops in population and industrial enterprises.

The year was one of general prosperity, says Mr. Parker, to both operators and miners. Production increased, prices advanced, and although there were no strikes for higher wages or changed conditions, some of the coal-mining companies voluntarily gave an advance of 5 per cent in the wages of their employees. During August and September, when the crops were being moved, there was a shortage in car supply, but as a general thing throughout the year transportation facilities were adequate.

The number of men employed in the coal mines of Utah in 1910 was 3,053, and that they were kept steadily employed is shown by the fact that each man averaged 260 working days. The average quantity of coal mined by each man employed was 824.7 tons for the year, or 3.17 tons for each working day.

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Tempering of copper is popularly supposed to be "one of the lost arts," but as a matter of fact is one that was never possessed to any higher degree than at present. It is safe to say that copper has never been tempered at any time by anyone, as it does not possess the necessary properties. Copper can be hardened in a number of ways; the easiest being to plunge the finished article into molten antimony or arsenic; the resulting alloy formed on the surface is exceedingly hard and brittle. Recent research in Mexico has shown that the tools there supposed to be made of hard copper were made by smelting mixed ores of copper, nickel, and cobalt; the resulting alloy, something like monel metal, was naturally hard. None of these old tools are of a quality equal to those which can now be made.—Mining and Scientific Press.

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For the benefit of those who may search for phosphate rock the following simple test is given: Place a small crystal of ammonium molybdate on the rock to be tested, then drop a little dilute nitric acid on the crystal. If the crystal turns yellow, it indicates the presence of phosphorus. The deeper the yellow, the higher the phosphate content.—Mining Science.

"RECENT PROBLEMS IN COPPER PRODUCTION"— "AN EDITORIAL REVIEW"

Under the above caption, as foretold in the September issue of Mines and Methods, Mr. T. A. Ricard's San Francisco publication, the Mining and Scientific Press, in its issue of October 7th, devotes five full pages to what it terms "An Editorial Review" of "Recent Problems in Copper Production," but which, in fact, is palpably designed as a defense of the operating methods of the Utah Copper Company. The writer wades into his subject boldly, and with the apparent purpose of engaging in a general review of facts and economic conditions which bear upon the production of copper throughout the United States and Mexico, but—as was to be expected—soon drifts into an elaborate eulogium and defense of the methods of the Utah Copper Company against the wholesome exposures which this journal has from time to time made public. This being the first real effort of the Press since its enlistment in the service of the Utah company's publicity bureau, and the result of the writer's first visit to "headquarters," he labors under the disadvantage of having been compelled to "compile his piece" from matter which had become threadbare from long service in being bowled back and forth between local dailies and Walker's Weekly Copper Letter and other Eastern publications which constitute the Utah company's promotion vehicles.

It should be here observed that the Scientific Press professes to be exclusively a "technical" journal and that the writings of its chief Editor on this occasion, therefore, necessarily embrace the very technique of steam shovel, as well as metallurgical and mechanical science, in so far as the same could be adapted to the material supplied by the management of the Utah company. But the writer was equal to the occasion. In fact, it appears that he was so skillful in polishing up the old "junk" and pandering to inordinate personal egotism that the manager became so charmed and bewildered in contemplation of the exquisitely scientific character of his own operations—as rehashed by this editor—that he allowed some ugly truths to escape "censor," because of the excessive technical character of the terms employed, the real import of which was evidently not understood.

The article opens so general in its treatment of the subject of its text and glides so gently into the task in hand and withal handles the matter with such exquisite skill that we feel sure that those who are interested in the efforts that are being made to market Utah shares will be pleased with the aid thus tendered by us in further promoting its publicity. Following are extensive excerpts from the article referred to and our own comment:

RECENT PROBLEMS IN COPPER PRODUCTION—AN EDITORIAL REVIEW.

It is not too much to say that development during the last decade has completely revolutionized the copper situation. How sweeping the changes have been may be seen from a comparison of the tables below.

Fifteen most important copper producers, 1901 (As given in Mineral Industry for 1902):

		Pounds.
1.	Anaconda, Montana	101,850,000
2.	Calumet & Hecla, Michigan	82,520,000
3.	Butte & Boston, Boston & Montana, Montana	58,029,000
4.	Copper Queen, Arizona	39,781,000
5.	United Verde, Arizona	34,520,000
6.	Montana Ore Purchasing Co., Montana	29,899,000
7.	Quincy, Michigan	20,540,000
8.	Arizona Copper Co., Arizona	20,535,000
9.	Tamarack, Michigan	18,001,000
10.	Butte Reduction Works, Montana	17,970,000
11.	Detroit, Arizona	17,535,000
12.	Osceola, Michigan	13,723,000
13.	Parrot, Montana	10,168,000
14.	Old Dominion, Arizona	10,094,000
15.	Colorado S. & M. Co., Montana	7,465,000

Fifteen most important copper producers, 1911 (Estimated):

		Pounds.
1.	Anaconda, Montana	250,000,000
2.	Phelps, Dodge & Co.	133,000,000
3.	Utah Copper	94,000,000
4.	Calumet & Hecla	74,500,000
5.	Nevada Consolidated	63,000,000
6.	Calumet & Arizona	50,000,000
7.	Greene-Cananea	47,000,000
8.	Copper Range	32,500,000
9.	North Butte	28,000,000
10.	Quincy	21,500,000
11.	Granby	21,500,000
12.	Ray Consolidated	20,000,000
13.	Miami	15,000,000
14.	Shannon	15,000,000
15.	Tennessee	13,000,000

Ten years ago the important factors in the situation were the comparatively rich sulphide ores of Montana and the Southwest, the native copper ores of Lake Superior, and pyritic ores in various places. Some years since the latter were objects of great interest and attention, and were expected to have great influence on copper production. Later experience has gone to show that this importance was perhaps overemphasized. Large masses of pyritic ores are not everywhere available and with those known to exist it is not at all easy to maintain the sulphur content at the high level necessary for carrying on pyritic smelting, and when this Ultima Thule is attained the smelter manager is likely to find himself in the toils of neighboring agriculturistis, as the problem of avoiding damage suits when smelting with over 30% of sulphur on the charge is by no means a simple one.

The advent of the so-called "porphyry coppers" has been the most significant event of recent years, and the important place which they have already taken is evidenced by numbers 3, 5, 12, and 13 in the table given above. To describe them somewhat epigrammatically, material not previously classed as ore is mined upon a larger scale and at a lower cost than before, by novel methods, and the resulting ore is milled with a greater recovery than previously deemed possible, with the final result that deposits which until recently had no value are now a source of great profit. SO MUCH ILL-CONSIDERED AND MISDIRECTED CRITICISM HAS BEEN LEVELED AT THESE ENTERPRISES THAT IT SEEMS DESIRABLE TO REVIEW BRIEFLY THE PROBLEMS MET IN THEIR EXPLOITATION. (Capitals are ours.) The following has been prepared after a brief study of the operations of the two most notable enterprises of this kind, the Utah Copper Company and the Nevada Consolidated Copper Company. To the officers of these companies we are indebted for the facilities afforded in the study of their operations. Further details of much interest, contributed by C. B. Lakenan, manager for the latter company, appears on p. 458.

In dealing with these recent problems of copper production, we have to do not with new species alone, but new genera. IT IS REMARKABLE, THEREFORE, THAT SOME HAVE FOUND THEMSELVES UNABLE TO BELIEVE IN THE RESULTS ACTUALLY ATTAINED. (Capitals are ours.) A rough but not inapt comparison is to say that these new methods of work bear to the older methods much the same relation that a street railway system bears to stages and omnibuses. In other words, it is the relation between a large volume of work carried on at a uniform rate with a low unit cost, and a smaller volume of work to which a larger degree of individual attention and effort is given at a higher unit cost. Where work is carried on at the rate of ten thousand or fifty thousand tons per day it permits the use of methods which eliminate the factor of individual attention which makes high unit costs. The "porphyry coppers" are large

masses of igneous rock which carry small amounts of copper ore, fairly uniformly disseminated throughout the mass. Size and uniformity of content are, then, the essential factors. The problems are to determine the size and uniformity of content of the deposit, to mine it as cheaply as possible with a daily production of many thousands of tons, to mill the product with a high percentage of saving and at a low cost, and then to smelt the concentrate as cheaply as possible. * * *

The cost of smelting Utah Copper concentrates is SEVEN DOLLARS PER TON, whereas the Ohio Copper Company, for treating precisely similar concentrates at the same smeltery pays ONLY FIVE DOLLARS per ton. The "rake off" apparently goes to the Guggenheims and is equal to about half a cent a pound on all copper produced.

MINING.

Practically only two types of mining methods are applicable to such deposits: (1) stripping and removal by steam-shovels when the deposit lies near the surface, and (2) some form of caving method when deeper seated. The latter methods have been developed in dealing with the iron ores of Lake Superior; their use in this connection has been so fully discussed elsewhere and their application to copper ores is so recent that no further discussion of them will be attempted here. Steam-shovel mining was also developed in handling the Lake Superior iron ores and has been applied with notable success in stripping and mining the "porphyry coppers," where with overburdens of one hundred feet or less in thickness and with three or more tons of ore uncovered per ton of capping handled, this method of mining is capable of yielding large daily tonnages at a low unit cost. * * *

The thickness of overburden on the Boston Con. section of the Utah—which embraces at least 80 per cent of the ore bearing area available for shovel mining —is given in the last annual report at 160 feet in thickness. True, Manager Jackling by an ingenious system of averages reduced this to 105 feet; but strange as it may appear, the shovels still have to plough through the 160 and more feet of capping regardless of the fact that 35% of its volume was averaged off and should have disappeared.

It is impossible in the limited space at our command to take up a detailed analysis of all the features of this work; nor does it seem desirable to do so; yet some points should be briefly alluded to. The contour of the ground has an important influence on this work. It is necessary to carry on the work in successive benches, separated by slopes of a height and steepness varying according to the sum of the conditioning circumstances. In our issue of March 4, E. E. Barker discussed in detail this question of permissible slopes, concluding that under the conditions obtaining in the Copper Flat pit of the Nevada Consolidated the most desirable slope for economical operation is 1.75 to 1. The Utah Copper, having steeper natural slopes and greater differences of elevation counts on using 1 to 1 slopes, and the high bank now carried on the edge of the big pit has a height of 250 ft. and a 50° slope, upsetting previous ideas as to the maximum permissible slopes. It is obvious that where the natural topography is steep it will be necessary to carry a large number of slopes, with a correspondingly great increase in the amount of trackage required, and of steep grades in order to reach the necessary elevations. On the other hand, some degree of compensation is found in the greater number of working faces afforded, thus allowing an earlier completion of the stripping of the orebody, and the more ample dumping ground for waste available upon a steep surface.

This explanation is extremely lucid—perhaps we should say "technical"—and evidently contemplates dumping the waste back in the low ground after the ore is removed.

As seen from the foregoing figures, the maintenance of tracks is a question of much importance; where these are greatly curved in the effort to "make grade" the cost of the increased wear and the added delays due to derailments and other mishaps are a not unimportant factor. Drilling and blasting are carried on by separate crews, and the separation of capping from ore is effected by drilling through the capping until the ore is met, the capping is then blasted off, and the ore later drilled and blasted. The ore surface is a warped one, and in passing from capping into ore a working face will at some period be partly in one and partly in the other. **This offers no difficulty where the transition occurs horizontally,** as the ore may be loaded into one set of cars and the overburden into another, but where the dividing line occurs part way up the slope it is impossible to prevent the overburden from sliding down and becoming mixed with the ore as the latter is being removed. This is not a serious matter, however, as no ore is lost thereby, and even if 10% of barren waste should become mixed with the ore its total effect would be to decrease the grade of ore from 1.50 to 1.37% copper, for example. At Utah Copper not over 4 or 5% of waste containing copper is mixed with ore while mining ore next to capping, and after the capping is completely removed the ore will be mined clean. On the whole work this is of but slight importance, but in every case there will be a period during which the slopes are passing out of overburden into ore when this will assume an exaggerated temporary importance. In an ideal mine it would be easy to plan the work so as to minimize all the factors which militate against economy in steam-shovel mining, but in any actual case disturbing factors cannot be avoided. For example, it may be necessary to work at a disadvantage in order to obtain an immediate regular supply of ore for the mill and smelter, where greater economy in mining could be obtained by postponing the removal of ore until stripping was farther advanced. For this reason the ore supply at the Utah Copper has at present to be supplemented by ore broken underground at a cost approximately four times that of open-cut work. A portion of this extra cost will eventually be returned by the saving in drilling and blasting charges when the filled slopes are afterward mined by steam-shovel.

The last sentence evidently is intended to corroborate the statement of Manager Jackling contained in his annual report, dated January 24, 1908, p. 14, wherein he says: "There are some advantages in continuing underground mining in some portions of the property because the ore mined in this way is taken from the ore bodies lying directly beneath the capping, resulting in the capping caving into the open stopes and BREAKING ITSELF. So that it is not necessary to blast it for steam shoveling."

This increased cost of mining of a portion of the ore may legitimately be regarded as a charge against the mill for keeping it in steady operation; in other words the cost of shutting down or operating the mill at part capacity is borne by the mine. It will readily be perceived that to an even greater extent than in ordinary mining the early operations are conducted at a disadvantage. Though the great capital expenditure for stripping is distributed over the life of the mine it necessarily, as a 'factor of safety,' imposes a heavier burden upon the early life of the mine when operating costs are higher than in the later work and the securing of the economies of full-scale operations are difficult. * * *

An important problem in milling is the loss of copper in material finer than 200 mesh. This is always more than half of the total loss, and would seem to be a strategic point of attack to secure an increase in saving. Unfortunately milling methods have, until recently, ignored this class of material, which is commonly designated as 'slime' and regarded as an impossible subject for treatment. Where its quantity and value are small this is a justifiable attitude, but where it represents the loss of millions of pounds of copper per year a closer scrutiny becomes necessary. Two lines of attack suggest themselves; to crush and separate the valuable mineral with the production of as little slime as possible, and to secure a better saving from the slime. The former method of attack has probably been pushed nearly to its limit in the mills of the Utah Copper Company, where practice in this regard exhibits a high degree of perfection. It is obvious that minerals cannot be separated in a coarse state which are present in a fine state of dissemination, nor can any ordinary ore be reduced to a fineness of 40 mesh by any known method of crushing without the production of large amounts of 200 mesh material.

Making a good recovery from material finer than 200 mesh is a disheartening task. That it is not an impossible one seems to be indicated by a screening analysis of the tailing from these mills, which shows that the tailing between 100 and 200 mesh has the lowest copper content of any. There seems no reason to believe that at 200 mesh an arbitrary line is overstepped, beyond which good recovery is impossible. But this may be

looked at in another way; if the material approximately 200 mesh in fineness is low in its copper content, while all the material finer than 200 mesh shows a fairly high average, it follows that the finest material must have a proportionately high content of copper, or as it is ordinarily expressed the copper minerals have 'slimed' in crushing. There is much difference of opinion over the proper definition of slime, but it may be defined for the present purpose as material which does not settle quickly. As the machinery used for making the separation of valuable minerals from gangue utilizes their relative settling ratio in some form or other, it is powerless to deal with material which will not settle.

Why will not fine material settle in water? The rate of settlement of solids in water depends chiefly on: (a) the relative density of the solids to the water; (b) the sizes and shapes of the particles; (c) the velocity of flow of the water; (d) the nature of the solids; (e) the ratio of solid to water; (f) the presence of electrolytes. The mass of the given particle is acted on by gravity, tending to make it fall in the water, while opposed by the various resistances indicated above. It is not clear at first why the size of the particle should affect its rate of settlement, but when taken in conjunction with the other factors the effect is clear. In dealing with a mineral particle consideration must also be given to what may be called its 'extraterritoriality,' an area immediately adjacent to the particle which exhibits phenomena as though it were actually a part of the particle. In other words, when a mineral particle falls through water the line of separation is not between the mineral and the water, but between the water which adheres to the mineral and the water through which this water-mineral aggregate is falling. This concept immediately introduces a highly complicated series of relations which are as yet imperfectly understood.

Suppose there is a series of perfect spheres of equal size made of different minerals, will each sphere control an equal 'extraterritorial' area, or will they be unequal? And, in dealing with spheres of different sizes of the same material, will the ratio between mineral area and extraterritorial area be equal for all sizes? It is not known, but the weight of present evidence inclines to the belief that they are unequal in both cases. Accepting this view, it may result that with small equal-sized particles of valuable mineral and gangue, the difference in extraterritorial area may so alter their relative settling ratios as to make a separation by any method based on settlement impossible. A further important point is the character of the solid. During fine-grinding some of the minerals present are converted into colloidal hydrates and silicates, as pointed out by R. E. Ashley in the Mining and Scientific Press of June 12, 1909. It seems probable that these colloids attach themselves to the sulphide particles, much as oil does, the resulting aggregate having a structure similar to that of an egg divested of its shell, the sulphide particles corresponding to the yolk and the colloids to the white. It is readily seen that this action would so increase the effective area of the sulphide particles as to militate strongly against their recovery by ordinary ore-dressing methods. Possibly the addition of milk-of-lime during crushing would be of service in preventing the formation of colloids. The effect of the presence of electrolytes has been studied in cyanidation, but little is known of its influence on ordinary ore dressing. Enough has perhaps been said to indicate that the problems involved in the milling of these copper ores yet requires much study and experiment. The operating staff is naturally jubilant over the securing of much better results than ever previously obtained; the management properly keeps its attention fixed upon the saving still to be made. Indeed, with tailing losses amounting to nearly three million dollars per year, this is a matter worthy of all the thought and experiment now being devoted to it. On the other hand, the old story of the superintendent who upon being asked why his recovery was not higher replied, "Copper is the cheapest thing I've got," is not without its point. * * *

Herein we have a full and complete corroboration of our most severe criticism of the Utah company's practice of grinding its ores with "Chile" mills, as a consequence of which nearly one-half of the recoverable contents of its ores have been reduced to an amorphous slime which renders concentration impossible by any known process and—as indicated by the Press writer—mineral of the value of millions of dollars have every year been allowed to drift away in the tailrace and thus become completely lost, and all because an abandonment of the stupid practice would have discredited the management and thereby have caused a collapse in the share market.

Our readers will recognize the "old story" quoted in the closing paragraph and attributed to an unnamed superintendent as an expression of Manager Jackling frequently made use of by him in answering criticism upon the excessive losses which persistently followed the excessive grinding and consequent sliming and loss of the valuable minerals.

WHERE WE STAND

Our technical neighbor, the Mining and Scientific Press, in its issue of the 14th inst., whilst conceding enviable qualities of excellence to this journal, adopts the gratuitous suggestion of Mr. Ricard of the London Mining Magazine, and confirms our consignment to the class of publications called "Market Letters." This is an unexpected distinction, but perhaps the Press is right. At all events we have deemed it to be the duty of this journal to keep the investing public informed of the tricks of unscrupulous vendors of over-valued shares, and expect to continue that policy, and if that be the office of a "Market Letter," perhaps we should not complain of being so designated. But we must insist that our position has at all times, and in every particular, been scrupulously and "technically" accurate, notwithstanding the assertion of our learned contemporary that IT does "not feel that it is the function of a technical journal to discriminate." But if a "technical" journal may not discriminate in respect to fraud and deception in matters of public concern, we fail to perceive any concern the investing public should feel in so-called technical journalism.

THE COPPER HANDBOOK

Vol. X, the tenth annual edition of the Copper Handbook, has just been received. The new issue of this work, which has heretofore been considered a standard authority on the subject of copper and copper mines for the entire globe, has 1,902 actavo pages, containing nearly 1,500,000 words, and, in addition to the miscellaneous chapters, lists and describes 8,130 copper mines and copper mining companies, in all parts of the world, this being the largest number of titles ever listed by any work on mining. The descriptions range from two or three lines, in the case of dead companies, wherein reference is made to detailed descriptions in past volumes at the period of their activity, up to twenty-one pages in the case of the Anaconda mine which yields one-eighth of all the copper made in the world.

The miscellaneous chapters of the book, twenty-four in number, treat the subject of copper from all possible viewpoints, there being chapters on the history, chemistry, mineralogy, metallurgy, brands and grades, alloys and substitutes for copper, with a copious glossary, and a chapter of statistics ending the book that contains forty odd tables, thoroughly covering copper production, consumption, movements, prices, dividends, etc.

The Copper Handbook is sold on the unique plan adopted nine years ago, the publisher sending the book by mail, prepaid, to any address ordered, without advance payment of any sort, and subject to return after a week's inspection. The price is $5 in a strong green buckram binding with silk headband and gilt top, or $7.50 in full library morocco. Anyone interested in copper, as a producer, consumer or investor in shares, should write the author and publisher, Mr. Horace J. Stevens, Houghton, Michigan, ordering a copy of the new Copper Handbook sent prepaid, subject to approval.

MINING POSSIBILITIES OF ISLAND OF CUBA

By H. H. NICHOLSON*

Cuba offers great possibilities to the prospector and to the miner. Its mineral deposits comprise a great variety of metallic and non-metallic substances. It has an ideal climate; labor is cheap and transportation facilities, both within the island and to the world at large, are good. Why these resources have remained for 400 years undeveloped is difficult to say.

The early Spaniards were seeking, primarily, gold and silver. They began sending gold from Cuba to Spain as early as 1512. When, a few years later, the richer spoil from Mexico and Peru began to appear, Cuba and the West Indies, as a source of mineral wealth, became a negligable quantity. It is possible that the Conquistadores, in exploiting those richer fields, overlooked and forgot that which at first seemed so attractive. Be that as it may, Cuba became an outfitting place, or half-way station between Spain and her other American possessions; a place for good supplies chiefly, and cattle, sugar, tobacco and coffee became the great sources of wealth, while Mexico and the West were being ransacked for gold, silver and the precious stones.

A noted Spanish geologist, lamenting the lack of a general knowledge of the mineral resources of the island, said: "Human attention clings by preference to customary objects, and since agriculture has from the beginning given constant and lucrative employment to the people, they have grown unmindful of and forgotten the exploitation of the rocks for the riches they might contain."

The Mexican peon is a born prospector and miner. He has as keen a nose for ore as the best of his American confreres north of the border. There is not a corner of Mexico that the gambucino has not scratched. This Cuban brother, on the other hand, is by nature and practice a farmer and cattle man. He picks up the "float" mineral that comes in his way; he may even wash gold from the river sands, but they excite no thrills and he returns to his "bohio" with as placid a mind as when he left it.

It is said that prospecting is not easy in the tropics, because of the rapid and luxuriant growth of vegetation. Quite true, yet prospecting is "no snap" anywhere. In Cuba, as in Alaska, every mountain stream cuts out its rocky gulches and concentrates their contents in its sands and gravels. Whatever the causes for it are, the fact remains that Cuba possesses a wealth of mineral resources that today remain practically untouched.

The ores of iron are at present the best known. They are of good grade, widely distributed, easily mined and shipped. Though known, in a general way for about 400 years, it is only within the last 30 years that they have been commercially mined.

Recognizing the potential value of the mineral resources of the island, the Spanish government, in 1883, decreed that: "For a period of 20 years mining companies should be exempt from all taxes on their land; that ores should be exempt from all export duties; that coal brought in by mining companies, for their own use, should be free from all import duties; that combustibles and ore should be exempt from the 3 per cent duty on raw material, and that mining and metallurgical companies should be free from all other imports; that for a period of five years, mining companies should be exempt from the payment of duties on all machinery or material for working and transporting ores; that vessels entering in ballast and sailing with ore should pay a duty of but 5 cents per ton navigation dues, and that vessels entering with cargo for mining companies should pay but $1.30 per ton navigation and port dues."

Island of Cuba

MILLIONS INVESTED.

Under this most liberal charter several American companies became interested in 1884 and later in the development of the rich iron deposits in Oriente province, near Santiago. The Jurugoa company, with mines about 16 miles east of Santiago, and the Spanish-American Iron Co., with extensive mines at Daiquiri, 20 miles east of Santiago, and at Mayari, on the north coast, near Nipe bay, are the principal iron companies in active production. The investments of these companies represent many millions of dollars and their plants are among the most extensive and up-to-date in the world. Their ores are quarried rather than mined, in the ordinary sense, and are handled from mine to steamer in the most economical manner. Steam shovels and gravity do the work. No ore is smelted on the island, but all is shipped to the United States. This means that mining costs and shipping charges are low and that ores are of a high quality.

The ores on the south coast are mostly magnetite and hard hematites in massive form enclosed in porphyry while those on the east and north coast, at Moa and about Nipe bay are, in general, limonites. They occur in blanket formation, carrying little or no overburden and overlie massive serpentine and related rocks. In some cases the surface deposits are in modular or spherical form, interspersed with scraps and masses like broken furnace slag. The natives name these deposits tierra de perigones, "partridge shot" soils, and muco de herrero, "blacksmith slag."

These ores, besides a high iron content, sometimes carry a small per cent of nickel or chromium and are, as a rule, below the Bessemer limit in sulphur and phosphorus. Shipments from these mines in 1909 amounted to about 1,000,000 tons. Apparently the supply is practically inexhaustible, as immense beds of ore of a similar character have been discovered near Moa bay and in the province of Camaguay, in the Cubitas mountains, near the north coast.

Iron ores of a good grade are known to exist in other parts of the island; not-

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ably through the Sierra Maestra mountains, on the south coast; near Trinidad and throughout Santa Clara and in the mountainous region of Pinar del Rio in the extreme west.

There is and can be no question of the great economical importance of Cuba as a producer of iron. Even now American and English prospectors are seeking out and denouncing the iron-bearing territory adjacent to these going concerns. As noted above, the wide dissemination of the ores of iron opens a fruitful field in this direction.

Although, at present, the iron minerals are the best known, most thoroughly prospected and most extensively developed, they really represent but a small fraction of the mineral resources of the country. Copper has been mined at Cobre, near Santiago, for nearly 400 years. The Cobre mines were discovered and, in a manner, opened in 1514. Systematic mining, though, was not begun until 1530, since which time these mines have been worked, with varying fortunes, until today.

The surface and oxidized ores were phenomenally rich and even the sulphides of the deepest workings has had a shipping grade. This mine has had a checkered history. Tradition has it that copper was produced here even before the coming of the Spaniards. This idea is based on the fact that copper implements and images found in the ancient Indian mounds of Florida, have been identified as having been made from Cobre copper.

COBRE'S GREAT RECORD.

Be that as it may, historical evidence points to the fact that the rich deposits at Cobre were known to the Spaniards as early as the founding of the city of Santiago, about 1514. One of the earliest official reports states, among other interesting facts, that "out of the veins of the nearby mountains comes copper at the rate of 55 to 66 pounds in a hundred of earth mined." For some three centuries copper was produced from these mines, in a desultory manner. About 1830 an English company came into possession of the property and for a number of years operated it in a systematic and scientific manner. They developed the ore bodies through a number of shafts, to a depth of 1,000 ft. or 1,200 ft. vertically, and by drifts and crosscuts, to a lateral extent of several miles. The troubles of the Ten Years War and the difficulties in handling the water caused this company to suspend operations.

After the close of the Spanish-American war, an American company came into possession of the property. They have partially unwatered it, possibly to a depth of 500 ft. or 600 ft., at present. After some expensive and unprofitable experiences in the way of smelting, leaching and concentrating, they have apparently settled down to mining and shipping the higher grade ores.

By official reports, they shipped about 60,000 tons in 1909 and are now shipping about 6,000 tons monthly. Their superintendent states "that all ores of copper are found from the red and black oxides in the gossan, to native copper in considerable quantities in the top of the sulphides and all varieties of sulphides down to clean chalcopyrites." The depth of the enriched zone of the sulphides has never been determined. It occupies, at least, the area from the 100-ft. level to below the 650-ft. level. In this area occur large lenses of 3½ per cent ore containing shoots of very rich sulphides. One stope on the 550-ft. level yielded 22 per cent ore. As, at the time when the lowest workings were mined, only ore of a high grade could be handled, it is safe to assume that the zone of enrichment extended this far. Official records in Santiago show that from 1830 to 1860 this mine is credited with a production of some $50,000,000.

COPPER WIDELY DISSEMINATED.

At present, Cobre is the only producing copper mine in the island, yet ores of copper are abundant and very widely disseminated. Throughout the Sierra Maestra range and in general in all of the mountain districts copper float is abundant. A few miles to the eastward of Cobre, boulders of amygaloid basalt occur with native copper amygdules. This formation is of the same character as that of the Lake Superior region of the United States.

In the province of Santa Clara nuggets of native copper are sometimes turned out in cultivating the fields. In one district of considerable area in this province, are numerous old workings, some of which, a generation or so ago, produced a large amount of high grade ore, most of which was shipped to Wales for sale and treatment. The high cost of transportation and the troublous times caused their abandonment.

On the north coast rich float and many old workings are found, especially near Sagua de Tanamo and Gibara, in Oriente; near Minas, in Camaguey, in the mountain and hill country in the northern part of Matanzas province.

At San Diego de los Banos, in Pinar del Rio, I had brought to me samples said to have come from the adjacent hills, which assayed 65.25 per cent copper.

Next to iron, copper seems to be the most abundant and widely scattered metal. From the report of the Cuban Department of Agriculture, Commerce and Labor, there was exported in the year 1909, by the one operating company, 59,430 tons of copper ores.

Third in importance, by reason of their abundance, are the ores of manganese. These ores also are widely distributed and are often of a sufficient manganese content, as mined, to pay a profit over and above mining and shipping charges.

The only operating mines, at present, are at Ponupo, near La Maya, a few miles northeast of Santiago, though there are two or three prospects near Cristo and Dos Bocas, between La Maya and Santiago that ship a little ore from time to time.

In Santiago province croppings and float are reported along the line of the Sierra Maestra range, from Guantanamo to Manzanillo. Manganese ore also occurs near Trinidad, in Santa Clara, and near Bohia Honda, in Pinar del Rio provinces. The official reports give the exportation for 1909 as 2,500 tons.

Lead and zinc, though not mined at present, are not infrequently brought to notice among samples submitted by the natives. I have heard of, though I have not seen, a lead-silver mine opened some years ago in the mountains west of Santiago.

GOLD IS ALSO THERE.

If one speaks of gold in Cuba he is apt to provoke discussion. Even some of those who are otherwise well acquainted with the island are more or less skeptical in regard to its mineral resources, and especially so in regard to gold. A few years ago these same people would have scouted the idea of Cuba ever being a source of iron to be figured in the world's production. Yet within that short time her export of iron has become a large factor in the total of the world's supply, and experts say that her iron ore now "in sight" can keep the pace for 100 years to come.

As to gold, the Spanish historian, *La Sagre, says: "It is probable that the exploitation of gold by the Spanish discoverers of the Antilles was limited to the simple washing of the sands in which the metal was found. Nevertheless, they were not long in finding profitable mines of gold, the existence of which was divulged by the Indians. * * *."

In a note concerning gold sent from Santiago to Spain in 1512, the statement is made that the shipment comprised a certain amount of gold which had come from Cuba, and in 1514 a letter from Diego Velasquez mentions that he had examined the localities from which the gold had been extracted, in the province of Guanabaya (probably now Oriente), and that he had also obtained gold that had been gathered by the Indians from

*La Sagra, Historia Fisica, politica y natural, de la Isla de Cuba, Madrid, 1842.

certain rivers, particularly in the neighborhood of the port of Jagua (Cienfuegos).

Between the years 1515 and 1534, according to records in existence, many consignments of gold were shipped from Cuba to the mother country.

About this time consignments of gold and silver bullion began to arrive from Mexico and Peru by ship loads and the adventurers in Cuba and enroute hastened to the newer El Dorado, abandoning the prosaic washing of river sands for the more glorious despoliation of the Indian kingdoms to the west. As the argonauts of '49 passed over the riches of the Rockies in their haste to reach the golden sands of Sutter creek, so these earlier argonauts passed by and forgot the riches of the Antilles.

I know of but one operating gold mine in Cuba today. This, by methods somewhat antiquated and uneconomically carried out, gives satisfactory returns to its owners. I have no doubt that, with up-to-date methods and the application of technical skill, its net returns could, at no great expense, be doubled.

On the north coast of Oriente province is a region some 10 by 30 miles in area, that is undoubtedly gold-bearing. In this region are many ancient workings, some of which antedate the coming of the white man.

Again, over a wide area in Santa Clara, are unquestionably gold-bearing formations. Good samples of auriferous rock have been given me, said to come from the Organos mountains in Pinar del Rio. In general, wherever one finds basic intrusive rock in Cuba, he will find more or less of gold-bearing ores.

Besides the economic and precious metals, Cuba possesses a great variety of non-metallic minerals: Asphalt, petroleum, graphite, asbestos, cements, clays, building stones, marbles and salt are some of her natural products.

ASPHALT, PETROLEUM, ETC.

Bituminous deposits (asphalt and its congeners) are found in abundance throughout the island. The most striking of these are the submarine asphalt mines in the Bay of Cardenas, and the tar wells of Hato Nuevo, about 30 miles east of Cardenas. The methods of mining—if it may be called mining—at these points, is unique. At Cardenas a lighter or barge, is moored over the submarine beds and a heavy iron bar, chisel pointed, something like the bit of a churn drill, is played up and down on the bed of asphalt by means of a winch on board the boat. This asphalt is about as brittle as cannel coal and has much the same appearance, except it is more dense and glossy. When a sufficient amount has been chiseled off, a diver is sent down, who fills it into a scoop net, by which it is raised to the boat. In this way they obtain from a ton to a ton and a half daily. This asphalt is of a very fine quality and brings from $80 to $125 per ton in New York.

At Hato Nuevo is a well, about 80 ft. deep, into which oozes a thick mineral tar. This tar is drawn out, by hand power, by means of a bucket and windlass. This well produced about 20 barrels of tar per day.

Petroleum wells and springs abound in Matanzas and Santa Clara provinces. One boring near the city of Santa Clara produces an oil of great purity. "It is colorless, transparent as water, easily inflammable and leaves no residue after combustion. Its density is 0.754; it dissolves asphaltum and resins."

These, of the numerous places where bituminous products are obtained, are mentioned to show the kind of development and the crude methods in use even after years of operation.

No coal beds of economic importance have yet been found. Small seams, from widely separated localities, have been reported.

Samples that came to me from near Trinidad assayed:

Volatile combustible	46.32%
Moisture	13.68%
Fixed carbon	34.00%
Ash	6.00%
	100.00%

Good building stone is abundant, marble, plain and variagated, of a fine quality and taking a high polish, is found in the eastern end of the island and in the Isle of Pines.

Lime and cements of excellent grade exist. The following analysis of raw cement rock from an extensive deposit near the south coast of Santa Clara, approximates very closely to the correct proportions for a Portland cement mixture:

	Cuban.	Portland
Lime $CaCO^3$	79.88	65.13
Silica SiO^2	14.96	20.42
Magnesia MgO	.72	.58
Iron and aluminum oxides	4.44	13.87
	100.00	100.00

In juxtaposition are clay beds whose mixture with this material would reduce the proportion of lime and increase the proportions of silica and iron.

There is but one cement factory in Cuba at present. It has a capacity of 1,000 bbls. per day and is said to produce a good quality at a cost of from 90 cents to $1.20 per barrel. Yet Cuba imports large amounts of cement from abroad. The importation for the year 1909 exceeded 500,000 bbls.

A FIELD FOR SMELTING.

The fact that all Cuban ores now mined are shipped to foreign countries for treatment, is a high tribute to their quality. This fact further signifies that here is an open field for smelting operations.

Virginia coal can be laid down in Cuban ports for from $5 to $6 per ton. Pennsylvania coke ought not to cost more in Cuba than in the western mining states, as the shipping distance is much less and Cuba has the further advantage of water transportation. In this connection I will call attention to the fact that Cuba has a great abundance of otherwise waste timber that makes the hardest and finest charcoal in the world. At present charcoal is the universal fuel in the island. The value of the charcoal consumed last year was upwards of $6,000,000. With one or two minor exceptions, all of this fuel is now made by the old uneconomical pit method by which all of the by-products are lost. With modern distilling plants these by-products will more than pay all operating cost and yield an unsurpassed smelting fuel at a minimum of cost.

The Cuban mining laws are liberal and progressive. Being of Spanish origin, they are similar to those of Mexico. The unit of concession is the pertenecia, 300 meters (984 ft.) long by 200 meters (656 ft.) wide, equivalent to 14.8 acres in area, for the precious metals and 500 meters by 300 meters (37 acres), for iron, coal, asphalt, etc. Claims are bounded by vertical planes and carry no extra-lateral rights. To the owner belongs all the mineral within the box enclosed by the boundaries of his claim.

There is no limit to the number of claims one person may take. His title is perpetual and he may work his claims, or not, at his option. The only cause of forfeiture established by the law, is failure to pay the annual tax. This tax, on mines of the precious metals is $30 per annum; in all other cases it is $12 a year.

The island is 750 miles long and has an average width of 50 miles. It is about two-fifths as large as Colorado; a proportionally large mineral area; a great variety of products, and equally favorable transportation facilities. Railroads traverse the island from end to end and from side to side. Numerous lines of steamers connect its various ports with all ports of the world.

The climate is unsurpassed: Average annual temperature, 78° F. Average annual variation, 12° F. Average annual rainfall, 52 in. The population is about 2,000,000, only 29 per cent of which is colored; the balance are Europeans and Americans.

LEACHING APPLIED TO COPPER ORE*

ELEVENTH ARTICLE REVIEWING RESULTS ACCOMPLISHED, WITH FURTHER REFERENCE TO UTILIZATION OF WASTE FURNACE GASES

By W. L. AUSTIN†

In the previous article of this series it was shown (Table IV) that using insoluble anodes and a sulphate solution, the results obtained by Reinartz indicated an approximate cost of $0.06 per pound copper deposited electrolytically. This cost, however, was based upon an expense of two cents per kilowatt-hour for current, which was assumed to be a conservative estimate for outlying districts where such a process would be likely to find adoption. In the subsequent experiment it was shown that under identical conditions, but employing sulphur dioxide as a depolarizer, the cost was reduced to $0.017. These figures, however, did not take into account the value of the sulphuric acid produced in the operation, which reagent is available for further ore-treatment.

Mr. William E. Greenawalt of Denver, Colorado, has also ingeniously applied sulphur dioxide to the reduction of ore carrying copper and other metals, and manufactures a powerful solvent almost wholly from waste furnace-gases—the very substance which is causing the clash between the mining and agricultural interests at so many points. In this connection it might be mentioned that the discharge of a moderate amount of sulphur dioxide into the atmosphere (0.75 per cent by volume of the exit gases) is legally permissible*, so that the removal of a portion of this deleterious compound from the escaping gases would fulfill the conditions necessary for continued operation at some of the plants now closed. Any metallurgical method, therefore, which makes advantageous use of sulphur dioxide, and at the same time converts sulphuric acid into insoluble salts while extracting a high percentage of the valuable content of an ore, must sooner or later find commercial application.

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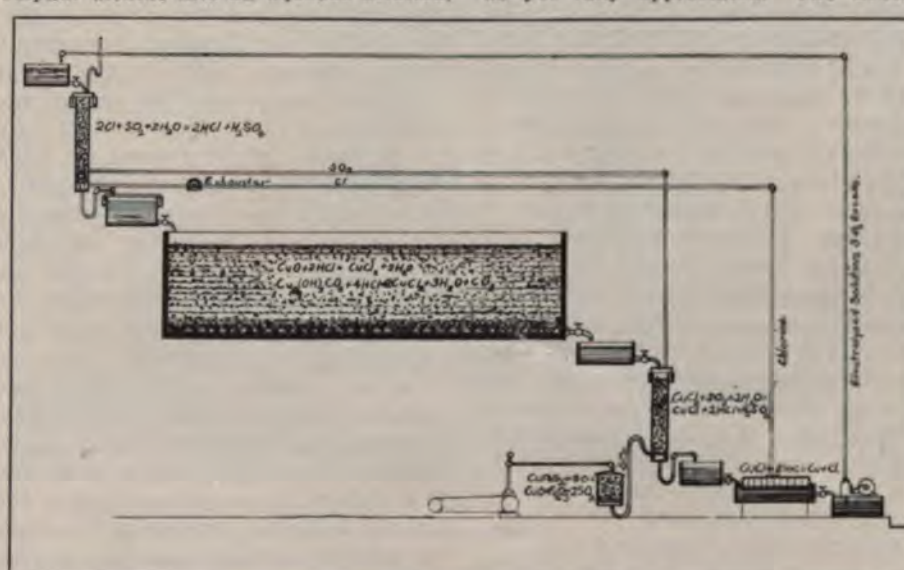
*The minimum of noxiousness in the case of spruce trees has been established at the density of one part sulphur dioxide per 500,000 parts of air, or 0.0002 per cent by volume, or 0.0071 gram sulphur dioxide per cubic meter.

The Greenawalt process is described in Engineering and Mining Journal of November 12th and 26th, 1910, and also in U. S. patent specifications Nos. 968,651, 968,652, 968,845, all patented under date of August 30th, 1910, and No. 973,776, patented October 25th, 1910. As set forth in the patented claims, it is a process of extracting copper from its ore which consists in leaching the ore with an acidified solution of sodium chloride, followed by electrolysis of the cupreous solution and regeneration of the solvent. A study of the papers referred to above is recommended as affording information of value to anyone interested in the application of wet methods to the reduction of copper ore.

The solvent employed in this process is generated by introducing chlorine and sulphur dioxide into an aqueous solution, which results in the formation of hydrochloric and sulphuric acids*. These two reagents naturally attack the metallic oxides present in the ore, carrying them into solution as chlorides and sulphates. The acid solution is constantly being regenerated in the course of the operations at the expense of sulphur dioxide derived from roasting sulphide ore, and it is stated that the consumption of chlorine is covered by the addition of two ounces common salt to the solutions for each pound of copper produced.

*Chlorine can be combined with sulphur dioxide to form at least two compounds, thionyl chloride ($SOCl_2$) and sulphuryl chloride (SO_2Cl_2). Both these are decomposed by water, forming in the first case hydrochloric acid and sulphur dioxide, and in the second, hydrochloric acid and sulphuric acid. The use of sulphuryl chloride in the treatment of ore of the precious metals has recently been made the basis of a patented process (British patent No. 13,488 of 1910).



Greenawalt Electrolytic Copper Process—Dirgramatic Sketch

A short time back the use of chlorine as such in the reduction of low-grade copper ore, would have been an economic impossibility, because of the expense attending the production of this element by chemical methods; but with the efficient apparatus now available for its electrolytic generation this powerful auxiliary is procurable today at small cost in almost any locality. The advance in electrolytic methods of producing reagents has wrought a great change in the scope of hydrometallurgical processes, the importance of which is not as yet fully appreciated. The Greenawalt process would thus appear to provide a means by which leaching with strong acids might be taken advantage of in regions where such materials are otherwise unattainable at a reasonable cost. Theoretically there should be no loss of chlorine in the process; but in practice some of the gas escapes, in addition to the loss of solution sustained by entanglement in the tailings.

There is in Denver a plant for handling ten-ton lots of ore by the Greenawalt process, and a number of tests have been made there; but as yet the process is not known to have been placed in continuous commercial operation at any point.

In carrying out the process the ore is crushed, and when not already oxidized, is roasted. Roasting may not always be necessary even when sulphides are

present: some of the chalcocitic ore of the Southwest yields its copper readily to a number of solvents, both acid and basic, without roasting.

When sulphur dioxide is passed into water at 68° F. one volume of water absorbs 39 volumes of the gas, forming sulphurous acid. On the other hand, chlorine is absorbed by water to a much less extent (one volume water at 46° F. absorbs three volumes chlorine gas, and when chlorides of the alkalies are present in quantity its absorbent capacity is less*). As stated above, when chlorine gas is passed into water which has been saturated with sulphurous acid, a series of reactions takes place which results in a portion of the water being decomposed, its hydrogen combining with chlorine to form hydrochloric acid, and its oxygen with sulphurous acid to form sulphuric acid. In this manner a large quantity of these two acids can be brought into solution. The following formula indicates the reactions:

$2Cl+SO_2+2H_2O=H_2SO_4+2HCl$.†

It will be noted in the above formula that by employing two molecules of chlorine, a molecule of sulphuric acid is produced in addition to two molecules of hydrochloric acid. Herein lies one of the advantages of introducing sulphur dioxide into the treatment, because both of the acids dissolve respectively a molecule of cupric oxide, whereas if chlorine alone were applied, without the intervention of sulphur dioxide, only half the amount of copper would be brought into solution. This is made clear by the reactions indicated in the following formulae:

$H_2SO_4+CuO=CuSO_4+H_2O$.

$2HCl+CuO=CuCl_2+H_2O$.

$2Cl+CuO+H_2O=CuCl_2+H_2O+O$.

As sulphur dioxide is a waste product and is usually available in large quantities, its consumption adds but little to the expense of operation, and with its help the pound of chlorine generated is made to go twice as far as when that reagent is employed per se, which gives this method a decided advantage over any relying solely upon chlorine as the active reagent.

*A cubic foot of chlorine weighs approximately three ounces; a cubic foot of water at ordinary temperatures can hold six ounces of chlorine. In making tests upon a large scale at Denver, no difficulty was experienced in bringing from 0.5 to 0.75 per cent chlorine into a chloride solution.

†As set forth in patent specification No. 973,776, preference is given to combining chlorine with sulphur dioxide outside the electrolyzer. The reaction indicated in the formula can only be realized in the electrolyzer with exceedingly small current densities, whereas fifty amperes per square foot have been used in depositing. This increases the power expended per pound of copper produced, but gives better results—another exemplification of the fact that only in rare instances is it possible to carry on two metallurgical processes in the same apparatus simultaneously.

After the ore has been crushed and roasted it is placed in suitable vessels for leaching, and the acid lixiviant described above is allowed to flow on to it. The copper oxide is, of course, immediately attacked by both acids, but in the presence of sodium chloride, which is an ingredient of the lixiviant, whatever copper sulphate may be formed is altered to chloride, so that practically all of the soluble copper is finally converted into cupric chloride, and the lixivium is then ready to go to the precipitating vats.

One of the objections urged against wet methods of reducing copper ore is, that in most processes the precious-metal content of the ore is left in the tailings. In the Greenawalt process it is aimed to extract both the silver and the gold along with the copper.

We know from the old pan-amalgamation method of treating silver ore that the addition of "bluestone" (copper sulphate), and salt (NaCl), to the charge of raw or roasted ore, resulted in the formation of cupric chloride, and with the assistance of this reagent the rapid chlorination of certain silver minerals was brought about, thereby facilitating the extraction of the metal. As both cupric chloride and sodium chloride are present in the lixiviant employed in the Greenawalt process, silver minerals will be attacked to a greater or lesser extent and carried into solution, the amount depending upon the form of mineralization in which the silver exists, when the ore is treated in the raw state. It is claimed for the process that in the manner indicated from eighty to ninety per cent of the silver in the ore may be extracted. With sulphate solution alone it is not practical to get the silver into solution, unless a very careful roast is made (Ziervogel's process), which is entirely too delicate an operation for use in the treatment of large quantities of low-grade copper ore.

That portion of the silver which goes into solution may be recovered by passing the lixivium through finely divided metallic copper, upon which it will be precipitated, or it may be extracted in the electrolytic vat together with the copper, as the chlorides of the precious metals are readily electrolyzed. Theoretically both silver and gold should be deposited on the cathode before the copper, but when present in very small quantities all three metals may appear simultaneously.

If gold is present in the ore it is proposed to dissolve it by increasing the quantity of free chlorine in the solution.* This amounts practically to utilizing the old method of chlorination (Plattner's process) which has long been employed in California for recovering gold from roasted pyritic concentrates. It is a slow though efficient means of extracting the metal, albeit at considerable expense. In the Plattner process the pulp is treated cold, and remains under the action of chlorine for some days, while in the extraction of silver it is best to heat the solution containing the cupric chloride. It would seem, therefore, that the separate recoveries of silver and gold have to be carried out disconnectedly, as indicated in patent specifications No. 968,652, pages 3 and 5. First the tracted with the application of heat, and copper and silver would have to be exthen the pulp allowed to cool before the introduction of the chlorine to dissolve the gold. The length of time that the pulp has to remain in the leaching vats pending the solution of the gold would be a factor in the economy effected by this method of treatment. In the Plattner process chlorine was usually passed to the moist pulp in the gaseous state, and not in aqueous solution as proposed by Greenawalt. An advantage in leaching with chlorine instead of cyanide of potassium is, that the acid present in the pulp does not have to be neutralized.

After the copper has been leached out of the pulp as far as practical, it is present in the solution in the form of cupric chloride. This lixivium can go at once to the electrolytic vats, but Greenawalt recommends converting the cupric into cuprous chloride with the help of sulphur dioxide as indicated in the following formula:

$2CuCl_2+SO_2+2H_2O=2CuCl+H_2SO_4+2HCl$.

There are several objects gained by this conversion. In the first place the electric current deposits double the amount of metal from the univalent copper in the cuprous salt than it does from the cupric compound where the copper is bivalent, and the energy* required per unit of copper to electrolyze a

*If a cold solution is used in leaching then the three metals (gold, silver and copper) are extracted simultaneously. This could only be done, however, when the silver content is low; should it be high, the ore might be given a chloridizing roast, as in the Longmaid-Henderson process, and then leached cold. If gold values predominate, the solution should be charged with free chlorine, and as much as possible of this metal extracted in the beginning.

*The theoretical voltage necessary to decompose copper sulphate is 1.27; for cupric chloride 1.114; and for cuprous chloride 1.419. Although the voltages required for the two chlorides are nearly the same, the amount of copper deposited in the case of the cuprous salt being twice that of the other, the energy required is only about 65 per cent.

cuprous salt is less than that for a cupric. Secondly, as shown in the formula, the acid lixiviant is regenerated by this method of treatment, and additions are made to it, increasing its strength. When current is subsequently applied to reduce the cuprous chloride, still further quantities of the active reagents are produced. An advantage claimed for chloride solutions in electrolytic processes is, that the insoluble anodes used are less subject to deterioration when the copper is deposited from salts present as chlorides than is the case when they are in the form of sulphates.†

It is apparent from the reactions indicated in the above formulae which take place during the several stages of this method of ore-reduction, that additions are constantly being made to the acid-content of the solutions. Sulphuric acid is generated from the sulphur dioxide introduced into the liquors, and this in turn acts upon the salt (NaCl) present, producing hydrochloric acid. As there are always other bases in a copper ore besides the metal sought, such as lime, ferric oxide, etc., these are of course to a great extent brought into solution, but subsequently thrown down as insoluble sulphates. In this manner an accumulation of large quantities of acid solution is prevented, and innocuous products which are formed may be discharged with the tailings. In most cases insoluble calcium sulphate, and the equally insoluble basic salts of iron, will remove most of the excess-acid generated. Should there still remain an undesirable excess of acid in the solutions, it can be neutralized by the caustic soda formed in the electrolytic cell in which the chlorine is produced. In the latter case chloride of sodium will be to some extent regenerated after all of the sulphuric acid has been neutralized.

After the cupric solution has been reduced to the cuprous state through treatment with sulphur dioxide, the latter salt, (held in solution by hydrochloric acid and chloride of sodium), is passed through the cathode compartments of electrolytic cells, where the copper is deposited in metallic form. The solution issuing from the cathode cells is treated with sulphur dioxide in scrubbing towers, and then passed through the anode compartments of the same cells. The object of the further application of sulphur dioxide to the solution is, to insure an excess of sulphurous acid that it may react with the chlorine liberated at the anodes due to decomposition of the cuprous chloride, thereby forming additional acid. The liquor issuing from the anode compartments is then ready to be returned to the ore-dissolving vats to be employed in the treatment of a new batch of ore. This cycle of solution, precipitation and regeneration may be repeated indefinitely.

It will have been noted that in the Greenawalt process not only is the acid radical employed being constantly regenerated, but FRESH SUPPLIES OF THE SAME ARE CONTINUOUSLY ADDED TO THE SOLUTIONS AT THE EXPENSE OF WASTE FURNACE GASES. This feature is manifestly of the greatest importance, because no leaching operation can be carried out without the consumption of some active reagent, and when the source of the latter is a waste material, which, if permitted to escape into the atmosphere does positive harm, its utilization in the manner described, in itself commends the process to careful consideration.

The average results from a number of tests made with this process at Denver afforded a basis for assuming that a deposition of one pound copper could be counted upon per kilowatt-hour for the energy expended in electrolysis. Better results than this were obtained in some instances, reaching as high as 2.6 pounds copper per kilowatt-hour; but the former figure was assumed in the estimates published in the articles cited above as a basis for computing the cost of producing copper. The following estimate of costs of ore-treatment by the Greenawalt process is taken from Engineering & Mining Journal of November 26th, 1910, page 1066:

TABLE SHOWING COST OF MILLING ORE

	Per ton ore.
Crushing to eight mesh	$0.20
Leaching	0.15
Electro-deposition and regeneration, not including power	0.25
Power, electro-deposition, 420 kilowatts	0.58
Repairs, renewals, etc.	0.10
Melting and casting into ingots	0.05
Superintendence	0.10
Interest on investment, $120,000 at 6 per cent	0.20
Amortization, $120,000 at 10 per cent	0.33
Total per ton of ore	$1.96
Cost per pound copper extracted, assuming extraction 100%	$0.0196

These figures include the cost of extracting the precious metals, if such are present in an ore, and are based upon the metallurgical treatment of 100 tons of five per cent copper ore in 24 hours, with power* at $50.00 per kilowatt-year ($0.0057 per kilowatt-hour) and a deposition of one pound copper per kilowatt hour. Roasting is not included, but an addition of $0.75 per ton is made to the estimated cost where this is necessary, bringing the total estimated milling cost per pound copper for sulphide ore up to $0.0271.

The approximate cost of a 100-ton Greenawalt leaching plant was estimated as follows in the article referred to:

Power installation	$ 50,000
Motor-generator set; 5000 amperes, 110 volts	10,000
Electrolytic department, electrolyzers, cables, etc.	25,000
Leaching department, eight 100-ton vats, pumps, etc.	10,000

Depositing Room Greenawalt Electrolytic Copper Extraction Experimental Plant, Denver, Colorado

†Carbon electrodes, even the best of them, go to "mush" very quickly in sulphate solutions.

*According to statements made by practical hydroelectric engineers a water-power plant in the west can be installed for about $150.00 per kilowatt, and power produced for about $25.00 per kilowatt-year. With power at $25.00 per year, and two pounds of copper per kilowatt-hour, the cost of extracting copper from a suitable ore should be low.

Crushing department, crushing to 6 or 8 mesh	15,000
Miscellaneous	10,000
	$120,000
Roasting department	30,000
Total	$150,000

Returning to the cost of milling as given above, the figures have reference only to expenses incurred after the ore is delivered in bins at the mill, and do not include cost of mining, nor is anything allowed for shipment of the crude metal to market, refining and selling expenses, etc. It is assumed that electrolytic copper is sufficiently pure to enable it to find a market close to the point of its production, but such is rarely the case. Some metal might be disposed of under exceptional circumstances for casting purposes, but the amount would be small. Attempts to find a local market for California copper have been made from time to time but have not met with success, nor are conditions in British Columbia different, where also electric power is sufficiently cheap to warrant refining. All copper, wherever produced, seems to gravitate to the large Eastern refineries, to be worked up and returned to points often close to those of its origin. Even Mexican and Japanese copper is shipped to our Eastern seaboard for refining.

Formerly copper made by the natives in certain parts of Mexico was hammered by local artisans into the form of large copper kettles and other useful articles, but the industry was of small dimensions. When making estimates of the probable cost of production it will have to be assumed that in the present state of the copper industry all metal produced in any considerable quantity will have to bear the expense of a trip across the continent, which, with refining and other charges added, will increase the cost from two to four cents per pound. This is not as it should be and is one of the artificial conditions imposed on the country by the great capitalistic combinations. The time will come when crude copper bars will not be hauled 3,000 miles to Eastern refineries, and then shipped back another 3,000 miles at an additional expense of two cents a pound to Western consumers; but for the present, estimates will have to be made on this basis.

For the purpose of instituting a comparison between the costs of producing copper in a leaching plant and in a large concentrating mill, the following figures are given, being the costs at the Boston Consolidated mill in the month of September, 1909, shortly before that company was absorbed by its neighbor.

Table showing cost of producing copper at the Boston Consolidated mill in September, 1909:

	Per lb. refined copper.	%
FOB reduction division	$0.0479	41.01
Reduction division	0.0415	35.53
General expense	0,0110	9.42
Marketing	0.0164	14.04
	0.1168	100.00
Credit for precious metals	0.0050	
Total cost of the copper	$0.1118	

The amount $0.0415 assigned to the reduction division includes all metallurgical treatment, crushing, concentrating, smelting concentrates, and converting matte to crude copper. This amount ($0.0415) should be compared with $0.0218, the estimated cost of producing metal by the Greenawalt process ($2.71 less $0.53, the sum allowed for interest and amortization). In comparing the two sets of figures allowance must be made for the facts that Boston Consolidated figures are actual working results; whereas those relating to leaching are estimates; and furthermore, the latter are based upon an extraction of 100 per cent, which is inadmissible;* but still the difference is striking, considering the basis of comparison—100 tons per diem as against 2400.

Boston Consolidated ore averaged in the month given 1.58 per cent copper. The recovery in the form of concentrates was 68 per cent, with a further deduction of five per cent from the content of the concentrates at the smelter, and 26 pounds additional per ton of converter copper handled at the Eastern refinery. The mill treated on the average 2400 tons of ore in 24 hours.

The expense of extracting copper from an ore after it has been delivered at the mill is only a minor part of the total, a matter which is often overlooked in making estimates. This important fact is illustrated by the figures given in the following table:

Table showing cost of treating ore at the Boston Consolidated mill in month of September, 1909:

	Per dry ton.	%
FOB reduction division	$0.967	41.06
Reduction division	0.837	35.54
General expense	0.221	9.39
Marketing	0.330	14.01
Total cost per ton	$2.355	100.00

There is a further point to be considered in comparing leaching with concentrating operations, which is, that the percentage of metal extracted from an ore is higher in lixiviation. Assuming a five per cent copper ore and ninety per cent extraction in leaching as against 65 per cent in the usual concentration mills, the ratio of metal produced per ton of ore would be as 90 to 65 pounds. Even if the costs of the two operations were the same, the 25 extra pounds of metal would very materially reduce the mining and general expense charges, while the others remained the same.

*It is expected with the Greenawalt process to get an extraction of 98 to 99 per cent from carbonate ore, and 90 to 95 per cent from sulphide ore.

COPPER IN IRELAND

A $73,000 company is being formed to acquire a mining lease of the Ardtully mines of copper, silver and lead situated between Kilgarvan and Kenmare, in the county of Kerry, Ireland, writes Consul Geo. E. Chamberlain of Cork (Queenstown). The property consists of 14 acres of land and the mining rights of adjoining property, comprising 265 acres.

An analysis made in the laboratory of Trinity College, Dublin, shows the mines are rich in copper, sulphur and arsenic, and the quality of the ore is stated to be superior to that of the Cornish mines, the average value exceeding $53 per ton. Assays show copper ore from 22 to 49%, and silver-lead from 18 to 75 ozs. of silver to the ton. A considerable amount of development work has been done, and the first ton of ore raised was sent without being concentrated, to Swansea to be smelted, the assay being 15 ozs. of silver, net value $7.74, and 15% of copper, valued at $30.84. Another sample sent shows as high as 61% copper.

Copper mining in Ireland in recent years has been of but little importance, chiefly on account of the low-grade ore, and the result of this new development will be watched with a great deal of interest.

Some important developments are reported from Copeton Diamond Fields. At the Deep Shaft mine, on 22nd July, very rich wash was encountered, no less than 65 carats of diamonds being obtained from less than half a load, and 42 diamonds were picked from the face. The diamonds are said to be of excellent quality, averaging nearly half-carat, and one weighing 2½ carats was discovered. Black diamonds have been found in this mine, weighing up to 4½ carats. It is estimated that this rich diamond deposit, which is 2 ft. in thickness, will yield 150 carats to the load. By these recent developments the permanency of the Copeton field as one of the richest diamond-producing centers in Australia has been assured.

The dynamo is a machine for converting mechanical energy into electrical.

DISSIPATION OF DUST AND FUMES

EXPERIMENTS MADE AT BALAKLALA AND SELBY WORKS WITH THE COTTRELL ELECTRIC PROCESS

Up to date the Cottrell system of fume condensation has been given its most thorough test at the Balakalala smeltery at Coram, Cal., which was recently closed by order of the U. S. Circuit Court, says the Engineering and Mining Journal in submitting abstracts of papers on the subject. However, in the trial which led to this adverse decision, the apparatus is credited with removing 72.8 per cent of the total solids, including sulphuric acid and sulphur trioxide, and it appears that at present the sulphur dioxide is the chief source of trouble.

The underlying principle consists in the discharge of high-tension currents through the gas to be treated. In a quiet body of any fluid, where the particles to be precipitated electrolytically need only to be agglomerated, alternating currents may be used, but in a swiftly moving body of fluid, such as flue gases, direct current is far preferable.

HIGH TENSION DIRECT CURRENT.

The first problem was to find some means of supplying this high-tension direct current, as the common mercury-arc rectifier used with alternating current was found unsuitable for this work, in which the electrodes in the flues are placed close together and worked near the potential of disruptive discharge. The process adopted consisted in stepping the ordinary alternating current up to about 20,000 or 30,000 volts, and commutating it into an intermittent direct current by means of a rotary contact maker, driven by a synchronous motor.

The electrodes consist of a smooth conducting plate and a series of points. The final form of the latter was due to the observation that a piece of cotton-covered wire leading to the discharge electrode showed a purple glow along its entire length. Discharge electrodes made of this material proved more effective in precipitating sulphuric-acid mists than any system of metallic points. To form the more durable electrodes required in practice, asbestos and mica were twisted with wire, the slight deposit treatment before placing in the flue, furnishing the conductivity for the slight amount of surface leakage necessary.

APPLICATION TO CONTACT ACID PLANTS.

The first experiments on a commercial scale were made at the Hercules plant of the du Pont Company, at Pinole, Cal. Contact gases from a Hannheim sulphuric-acid plant, containing about 4 per cent by volume of dry SO_2 were worked on.

The apparatus consisted of two concentric wire-screen cylinders serving as discharge electrodes; a third cylinder, intermediate in size, resting on the lead bottom pan of the apparatus, and an outside leaded-glass cylinder, served as the collectors. Current was supplied by three 1-kw. 110-2200-volts transformers in series to give 6600 volts. The interval between the screens was about 1 1-4 in. About 100 to 200 cu. ft. of gas per min. were treated at a power consumption of about one-fifth kilowatt. This installation has since been supplanted by one on a commercial scale handling the entire output of a Mannheim unit.

PARTING PLANT FUMES CONDENSED.

The next installation was that at the Selby Smelting and Refining Company. The first problem attacked here was that of the fumes from the parting kettles. These were passed through a lead flue 4 ft. square in which were placed a number of lead electrodes 4 in. wide by 4 ft. long. Between each pair of these electrodes was hung a lead-covered iron rod, carrying the asbestos or mica discharge material, the latter being more effective in a highly acid atmosphere. These discharge electrodes were supported on a gridwork of busbars, which extended over the heads of the lead plates and through apertures in the sides of the flue to insulators on the outside. When the parting kettles were running at full capacity a stream of about 2 gal. per min. of 40-deg. acid issued from this flue. The current was taken from the regular works power circuit of 460 volts, 60 cycles and transformed to 17,000 volts, then sent through the synchronous-contact maker to the electrode system. At first a glass-plate condenser was connected across the high-potential line in parallel with the electrode system, in order to assist in maintaining the potential of the electrode between the intervals of contact, but this was found troublesome and unnecessary. The power consumption for this installation was about two kilowatts, including the driving current for the synchronous motor. The installation has been in successful operation for over three years and costs for labor and repairs less than $20 per month.

The next undertaking was the extension of this process to the treatment of the gases coming from the roasting furnaces of the same plant. It is impossible to treat these gases in a bag house owing to the corrosive action of the large amount of sulphuric acid in them. The material to be removed consisted of a mixture of solid dust and fumes with liquid sulphuric acid. The final apparatus consisted of a sheet-lead flue 6x6x32 ft., containing 38 rows of 16 lead plates each, each 6 ft. long by 4 in. wide, with corresponding discharge electrodes between each pair. This flue, 6x6x36, treated about 50,000 cu. ft. of gas per min., or about the same volume of gas as would be treated in a baghouse measuring about 55x98x125 ft. A test with such a baghouse showed that the woolen bags are completely destroyed by these roaster gases in less than half an hour. In this case the power consumption was between 10 and 15 kilowatts. The material precipitated upon the plates was a grayish mud, easily washed off and drained out through the bottom of the flue to settlers. For this purpose it was necessary about once every four to six hours to bypass the gases, shut off the electric current from the flue and wash off the electrodes from above.

GASES MUST BE PRECOOLED.

In order to insure the complete precipitation of sulphuric acid and arsenic from these gases and to protect the lead construction from softening, it was found necessary to cool the gases down below 150 deg. C. To accomplish this a system of water sprays was used in the mouth of the lead flue just before the electrode. These served the purpose well as long as clean water was available, and successful test runs for a week or more duration were made with this system, but as the general circulating and cooling water is derived from the Sacramento river, which is often muddy, the difficulties of keeping the sprays clean determined the management of the plant to resort to cooling through radiation by a long flue before the precipitator. This has not yet been done, as it seems that the present litigation with farmers has resolved itself into a question concerning the sulphur dioxide which, of course, is not precipitated by this system.

THE BALAKLALA INSTALLATION.

The next installation was that of the Balaklala smeltery, which treats from 700 to 1000 tons of ore, carrying about 30 per cent. of sulphur per 24 hours. The

great proportion of this is handled in blast furnaces, but everything smaller than one inch goes through the MacDougal roaster and an oil-fired reverberatory. The plant also has two converter stands. The gases from all departments passed into a common flue 18 to 20 ft. in cross-section. The volume of gas passing through this flue varied from a quarter to a half a million cubic feet per minute, which means a linear velocity in the flue of from 10 to 20 ft. per second.

A system of nine electrical precipitation units was built. Current was taken from the company's three-phase power circuit at 2300 volts, 60 cycles, and was transformed to from 25,000 to 30,000 volts and distributed to the electrodes. The collecting electrodes were grounded and were each 6 in. wide by 10 ft. high made of No. 10 sheet iron. The discharge electrode consisted of two iron-wire strands, between which was twisted the discharge material, both asbestos and mica preparations being used in this plant. Each of the nine units contained 24 rows of 24 electrodes of each type. The collecting electrodes were carried by bars connected directly from the chambers themselves, while the discharge electrodes were held by springs between a system of busbars carried on externally placed insulators.

MECHANICAL SHAKING TRIED.

Originally a cam and shaker rod extended across the middle of the units, for vigorously shaking the electrodes. In practice, though, it was found that a slight shaking by hand was quite sufficient and the entire operation of cleaning, including cutting the units in and out of the system, and the removal and the replacement of its covers, required only about 10 minutes; this having to be repeated every six or eight hours, depending on the dust content of the gases. The precipitated dust and fume as it falls from the electrode is carried away by a mechanical conveyer in each unit to a common longitudinal conveyer, which in turn discharges into cars. Under operating conditions at the smeltery from six to eight tons of precipitate were collected per 24 hours. The entire cost of the installation up to the time when it was first put into operation was $110,000.

The total average power consumption for the preciptation was in the neighborhood of 120 kw. One man can readily control the whole operation in the rectifier house, while two laborers and the foreman are employed on the precipitating units and the dust-handling system.

One of the greatest difficulties met with in this system has been the maintenance of conductivity in the fine fibers of asbestos and mica of the discharge electrode. At ordinary temperatures these materials readily take on enough moisture from the air to afford sufficient surface leakage for all the discharge necessary, and the same is true at higher temperature to the gases containing traces of sulphuric acid or other conducting matter, but in the particular gases met here with a high and variable amount of zinc oxide, which at times robbed them of all conductive matter, the conductivity of the fibers of the electrode is seriously reduced.

PRESENT STATUS OF PROCESS.

The Balaklala smeltery is now closed until it can conform to the original decree of the U. S. Circuit Court, which is that all solids must be removed, that there must never be over 0.75 per cent of sulphur dioxide in the exhaust gas and the gases must do no damage. Unfortunately the solution of the sulphur-dioxide problem is one which does not yet seem to be in sight.

It is proposed also to try the Cottrell system of condensation on the problems of the collection of dust arising from portland-cement plants, which are always serious annoyances to their neighbors. The process is also being tried in the cleaning of iron blast-furnace gas for use in gas engines. Outside of the poisonous and combustible nature of these gases and the consequent necessity for keeping the whole apparatus gas tight, there would appear to be no new difficulties here, and the matter is now being tested on a practical scale.

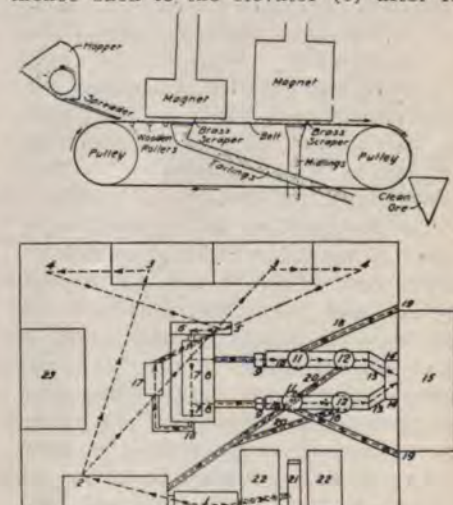
MAGNETIC ORE SEPARATION

The following is a description of the method employed by the Joplin Separating company, of Joplin, Mo., of treating low grade iron-zinc ores, so as to produce a high grade zinc concentrate. It was written by Lucius L. Wittich and appeared in last month's issue of Mines and Minerals:

The ore is first cleaned of sand, chatts, galena and other foreign matter in jigs and on ordinary tables; but where this has already been done the ore goes direct to the roasting ovens (3) instead of to the sizing screen (1) and the jigs (2).

The roasting ovens, of which there are two, consist of one firebox and three eyes each. In the first eye, nearest the furnace, one charge of 1,500 pounds may each may be roasted in 12 hours; in the second eye from the furnace, two charges of 1,500 pounds each may be roasted in 12 hours; in the third eye from the furnace, one charge of 1,500 pounds may be roasted in 12 hours.

From the eyes the roasted ore is wheeled in barrows to the cooling floors, (4) and when cooled is ready for the separator, first being wheeled to the receiving hopper (5), from whence it is elevated by a cup elevator (6) to a revolving screen (7). The upper half of the screen is equipped with wire mesh with openings one-eighth inch square. The ore that passes through this feeds into a large hopper (8), which is divided into two parts by a partition running crosswise through the center. At the lower end of the revolving screen is a perforated iron mesh, the holes being one-sixth inch in diameter. Ore passing through this also falls in the other part of the hopper. The object of the different sized mesh is to secure different sizes of ore for the two separators with which the plant is equipped. The oversize from the screen (7) passes to the rolls (17) via the launder (16) and thence back to the elevator (6) after it



Flow Sheet of Joplin Separating Co.

has been ground. In this manner the ore continues to circulate until it will pass through one or the other sections of the screen.

From the hopper the ore descends by gravity through launders to the distributing hoppers (9) at the upper ends of the belt conveyors (10). At the base of the distributing hoppers are spreaders on to which the ore falls and is conveyed in an even layer to the slow-moving belt conveyor beneath the magnets (11) and (12). One of these belt conveyors is 12 inches wide; the other 18 inches. They operate over wooden pulleys about eight feet apart, and are prevented from sagging in the passage beneath the magnets by wooden rollers.

The magnets consist of cylindrical soft-iron shells which cover helices of copper wire. The shells are 20 inches in diametear, but differ in height, the first magnets beneath which the roasted ore passes being 10 inches high, while

the second magnets—the more powerful ones—are 20 inches high. The magnets revolve slowly and the iron oxide is attracted to their surface is scraped off into launders by means of brass knives, which cause it to fall vertically.

As it is imperative that the recovery of blende be thorough and yet contain as little iron as possible, a careful regulation of the electrical current is required. The iron oxide scraped from the first magnets (11), beneath which the belt conveyer passes, goes direct to the waste pile and is of not further value save to be used in road making, sidewalk building, etc., and even for such purposes it is in little demand owing to its unattractive color. These weaker magnets range in power from 2 to 5 amperes, the variation being due to the different kinds of ores treated. Some ores will respond to a slight magnetism while others require a more powerful force.

The object of the weaker magnets therefore is to attract only the iron particles that are virtually free from zinc ore, although a small percentage of ore is bound to escape with the waste through the launders (18) to the tailing piles (19).

As the belt conveyor passes beneath the revolving magnets its surface is about three-quarters to one inch beneath the surface of the magnet, and across this space the iron particles rise to the magnetized zone of the apparatus. This zone is five-eighths of an inch wide, is near the extreme outer edge of the round face of the magnet extends entirely around the magnet, and represents the gap between the positive and negative poles, this narrow strip being the one point of the entire surface to which the iron particles are attracted. As the magnet swings around, bringing the clinging particles of ore against the brass knife, the product is scraped loose.

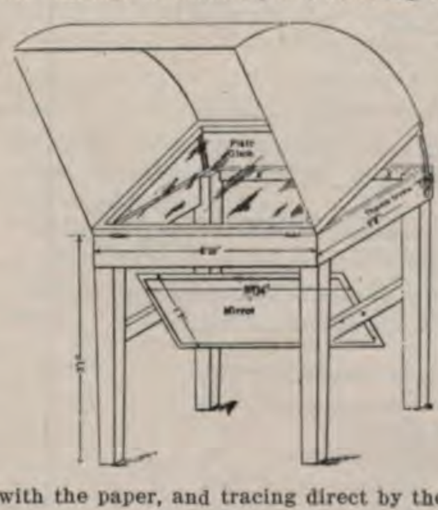
Passing beyond The first magnet, the belt goes beneath the second magnet which ranges in power from 9 to 12 amperes and attracts a heavy volume of particles that contain some zinc. A pin point of iron attached to a piece of zinc 50 times heavier than the iron, will respond to the magnetic force and jump upward to the magnetized zone. The ore that succeeds in getting beyond the second magnet and reaching the trough (14) at the end of the belt conveyer is therefore as free from iron particles as it is possible to get it. The cleaned ore passes to an elevator (14) and is lifted to the clean ore bin (15). It is in demand, as it is equal to the ores produced from the high-grade mines of the district.

To discard in the waste pile the particles that adhere to the powerful magnets (12) would cause a loss of zinc, therefore, the scrapings, instead of going to the tailing pile, fall into launders (20). The product is sized, (1) and (2), that passing through a mesh of 3-millimeter going to the jigs, while that passing through a 1-millimeter and a three-quarter millimeter mesh goes to the tables. The oversize goes to rolls (17), where it is reground and returned to the magnetic separators.

HANDY DRAFTING TABLE

By A. T. SCHWENNESEN.*

Every engineer has occasion to trace or copy a map plan, or other drawing on paper too thick for the ordinary way of using tracing-cloth or tracing-paper. When the figure is small and simple a copy may be made by holding the original against a window-pane, covering it



with the paper, and tracing direct by the aid of the strong sunlight from outside. The need of utilizing this principle on a larger scale and in a more convenient position led Dr. J. C. Branner to plan the table of which the following is a description:

This table was first made in the form of an adjustable glass-top table, with a mirror beneath, in 1887, while Dr. Branner was State Geologist of Arkansas. Later it was modified as experience suggested until the form as here described was evolved.

The device consists essentially of a drafting-table with a plate-glass top, upon which the original drawing and the paper are laid, and a mirror mounted underneath to reflect the light of the sky up through the drawing. The glass top is hinged and fitted with two arms and thumb-screws, so that it can be raised and fixed to any position, either inclined or horizontal. The mirror is pivoted and revolves about a horizontal axis, so that it may be tilted to any angle. The hood of cardboard or black cloth prevents the reflection of light from the tracing, and may or may not be attached to the table.

The apparatus is set up before a window through which part of the unobstructed sky is visible. The mirror is then adjusted like the reflector of a microscope, so that the sky light is reflected up through the drawing. If the mirror can be so located that the direct rays of the sun are reflected through the drawing, thicker paper can be used.

The map or drawing may be held in place by clips screwed to the top of the plate-glass frame or by lead weights placed on top of it.

The sketch gives dimensions and shows the general appearance of the table in use in the department of Geology and Mining at Stanford University. The dimensions may be varied to suit individual needs. An important point to be remembered in the construction is that the piece marked X should be made as narrow as possible, so as not to shut out more light than necessary. The frame of the glass top also should be made narrow at the top for the same reason.

This table can be used at night by employing an electric light, so placed as to be reflected or even to shine directly up through the plate-glass table-top.

It sometimes happens that the light from beneath is inconveniently strong, but this objection can be obviated by cutting a small opening in a piece of thick or dark paper, which is laid over the drawing. The tracing can then be done through the hole, and the sheet can be moved about at pleasure, which gives the advantage also of preventing the tracing from being soiled, and it often brings out more clearly the lines to be traced.

*Transactions of the American Institute of Mining Engineers.

The engraving division of the United States Geological Survey printed during the fiscal year ending June 30, 1911, 7,283,894 geologic, topographic, and other maps, many of them in several colors, each requiring a separate impression. Some of the geologic maps require as many as twenty printings. The total number of printings during the year's work was probably not less than 45,000,000 or 50,000,000.

A cubic foot of water contains 7.48 gals. and weighs 62.5 lbs.

ECONOMICAL METHOD OF SHAFT TIMBERING

By HUGH G. ELWES.*

The scarcity of timber in certain districts has led mine operators to try to use timber of less dimensions than those commonly employed in places where lumber is plentiful and consequently cheap.

The Nevada camps, especially Goldfield, are examples of places where the smallest timbers compatible with safety have been used. The light sticks used have been thought too weak by some, but practical experience has shown that all purposes have been well served and no failures of timbers have been recorded.

The writer ventures to suggest that in very many cases timbers much larger than those required are used. Beside the extra cost of big sticks, the lost space in the shaft is an objection, and in a large number of instances the timbering of the shaft is necessary only to support guides, ladders, pump lines, etc. A shaft in anything like good ground needs only light timbers such as those shown in the drawings, and if properly wedged, the latter, in combination with continuous lagging, will prevent rocks falling into the shaft as well as heavier sticks and at much less cost.

The drawings show the framing of timbers for a small two compartment shaft, each compartment measuring four feet by four feet in the clear, inside the timbers. All the sticks are six inches by six inches, except the special wall plates at the collar, and the special end plates of the bearer set which are six by tens.

Referring to Fig. 1, it will be seen that the end plates fit above the wall plates, and that both have a beveled shoulder to afford additional resistance in resisting side pressure. Daps are cut, one inch deep to receive the ends of the corner posts. These corner posts have plain squared ends but the center posts have a one inch tenon fitting into the dap in the wall plates as shown.

The girts have a one inch tenon beveled on one side, which is always the right hand side in end elevation. The wall plate is framed as shown, so that all are the same, without any right and left hand plates, and any girt can be put in in either direction.

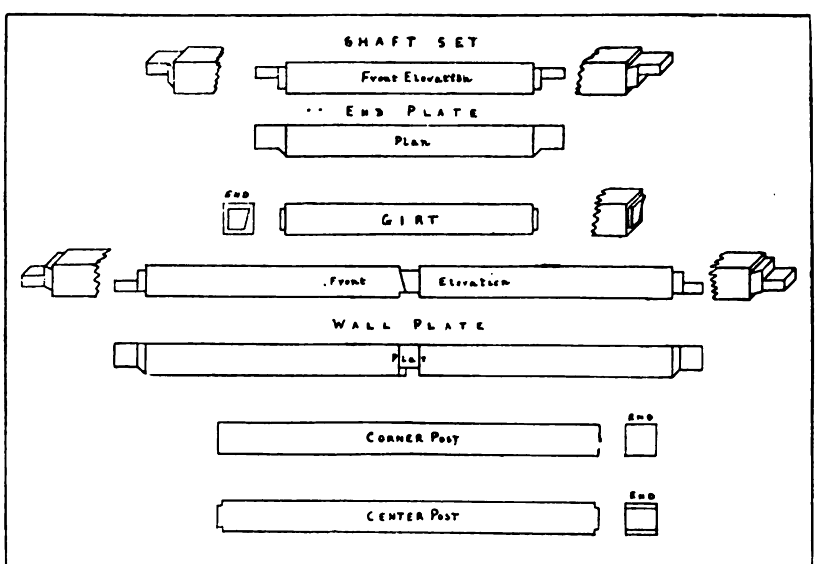


Fig. 1

The dap in the center of the upper and lower sides of the wall plates is so framed that girts and center posts can be temporarily omitted to permit the lowering and swinging into position of the wall plates.

The small perspective drawings of the ends of the various sticks are given to make the framing more intelligible.

The distance between sets is six feet in the clear or six feet six inches centers.

In framing, all measurements should be governed by the upper side and the inner face of each stick, so that any irregularities in them will not affect the alignment of the shaft nor its inside dimensions.

Figs. 2 and 3 show respectively perspective views of the skip compartment and ladder way, since a drawing showing the whole shaft would be too large for convenient use.

To avoid confusion the hanger bolts are shown only in the drawing of the skip compartment. These hanger bolts are of one inch round iron, ordinary nuts being used with extra large washers. Holes are bored in the wall plates nine and eighteen inches from the edge of the end daps, and the hole nearest the end is useful in lowering the stick, since a short piece of round iron passed

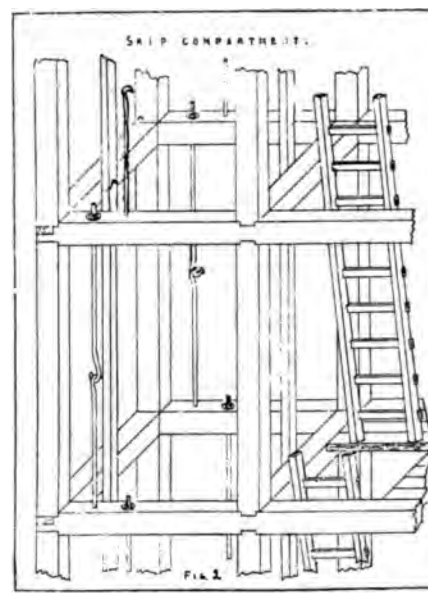


Fig. 2

through, having a thread at each end makes a convenient means of suspending the timber. The lagging of one inch boards is not shown so as to leave the drawing simple. Needless to say this lagging is placed outside the tim-

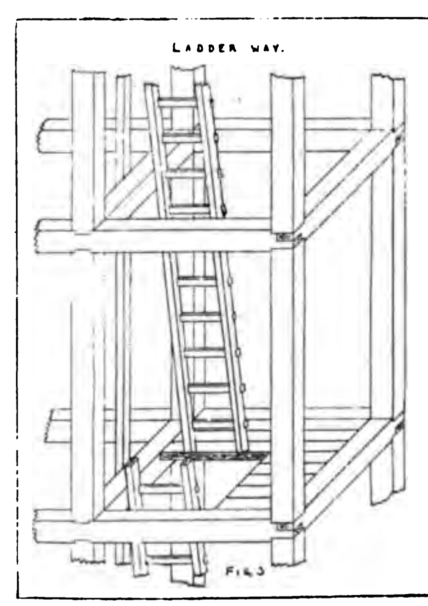


Fig. 3

bers, though the writer saw a shaft in New Mexico lagged on the inside, making a rectangular tube.

In Fig. 2 the guides are shown. These are made of two by four inch lumber and engaged dogs on the cage or cross-head.

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*Mining Engineer, Papantla, Veracruz, in Mexican Mining Journal.

If the shaft sets are in proper alignment there is no need for any piece between the end plate and girt and the guides, but sometimes a small space block is used, so that the guide can be put true by varying the thickness of the block.

In Fig. 3 the ladder way contains a series of ladders each reaching the height of two sets, and placed vertically over each other as shown. The manholes in the platforms at every other set are two feet six inches square. The tops of the ladders project above the platforms and hand holds are also placed above so as to facilitate stepping onto the flooring. The ladders are made of two by four lumber, the rungs being set apart at ten inches centers. The width of the ladders is eighteen inches over all. Each ladder is securely spiked in position and not left loose or half balanced. The steam pipe and water column for the pump and air line for the drills are carried in the ladder compartment, and the arrangement shown permits of any part of these pipes being easily reached.

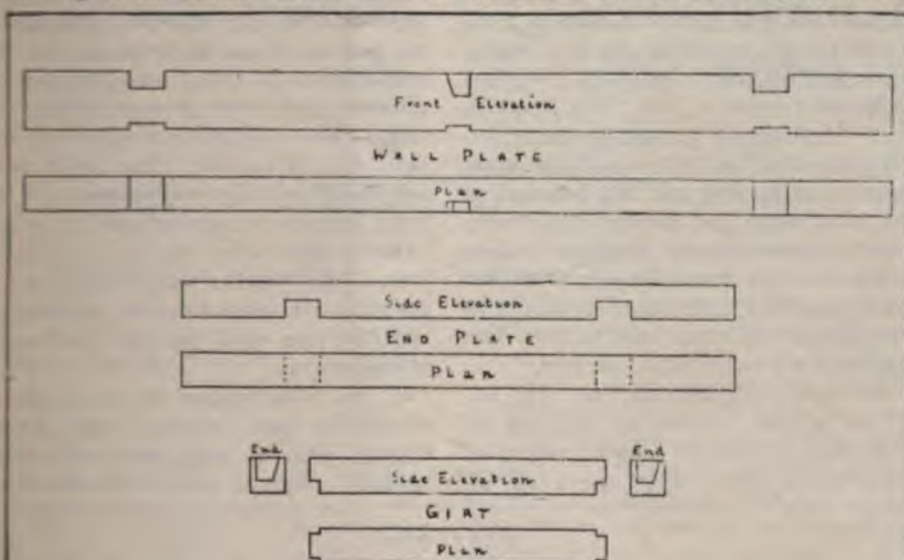

Fig. 4

Figs. 4 and 5, showing the collar of the shaft, are self explanatory, but it may be added that the writer uses concrete walls down to six feet from the surface, making the section of the shaft for that distance from the surface big enough to admit a thickness of eighteen inches behind the timbers. The timbers of the collar are bolted down into concrete piers forming extensions of these lining walls, but only three feet deep.

At every tenth set a bearer set is introduced. The bearer consists of an end plate made of six by ten lumber instead of six by six and there is a little difference in framing as shown in Fig. 6, on the following page.

To maintain the distance between sets the posts are cut four inches shorter immediately below the bearer.

The ends of the bearers are set into hitches cut in the walls of the shaft, and their use will increase the security of the whole job a great deal. Where the ground is at all soft or wedging difficult, the hanger bolts are replaced when removed by permanent bolts extending from one set to another.

By increasing the over-all dimensions of the sticks shafts of larger size can be timbered from the designs shown, and if another compartment is wanted, a simple butt joint and a reduction in the length of the tenons on the end plates enable it to be added without trouble, but for three compartments each of four by four feet, the wall plates might well be designed in one piece, with extra girts to divide off the extra compartment.

Nothing very new or original is claimed for these few remarks, except that part relating to the exaggerated conception some miners have as to the safe size of timbers.

A shaft designed as shown can always be utilized for hoisting with a double drum hoist by merely removing the platforms in the ladder way. The appearance of a shaft timbered as shown is very neat, and no trouble from any cause has been experienced.

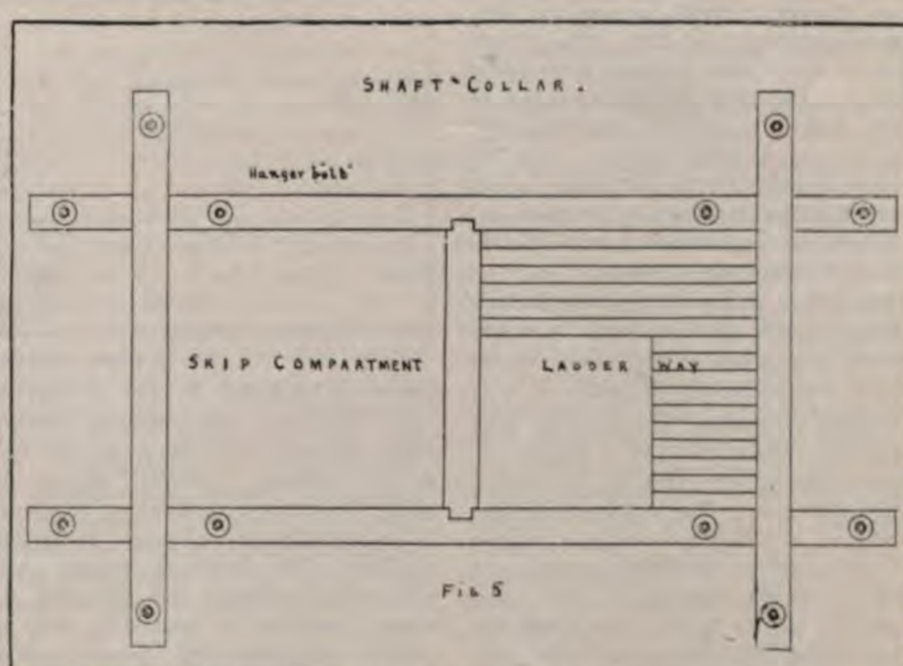

Fig. 5

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Asbestos, according to J. S. Diller, plays a more important part in the national life than is generally credited to it. The well-made asbestos curtain assures safety of the audience from stage fires. In the home the asbestos covering of the furnace and heating pipes, or of the gas logs in the open fireplace, makes for economy and comfort. Wherever steam is used as a motive power in factories, on trains, or on ships, it is asbestos packing that holds the steam to its work; on the other hand, if electricity is employed the wires are probably insulated by asbestos tape and the adjacent parts are made of asbestos "lumber." Asbestos shingles and sheating make houses cooler in summer and warmer in winter and reduce the fire risk. From the ice-house, where asbestos protects the brine pipes from the heated air, to the foundry, where it shields the workman from molten metal, in the workshop, the home, or the place of amusement, asbestos contributes materially to human welfare.

UTAH MINE PRODUCTION FOR CALENDAR YEAR 1910

The total value of the mine output of gold, silver, copper, lead, and zinc in Utah in 1910, according to V. C. Heikes, of the United States Geological Survey, was $32,199,185, against $31,380,092 in 1909.

The total gold production in Utah in 1910 showed a decrease in value of $174,463, or 4.3 per cent. The largest producer of gold was Salt Lake County, which yielded $1,776,058, against $1,780,573 in 1909. The West Mountain or Bingham district produced $1,767,992 of the gold credited to Salt Lake County and 43.8 per cent of the 1910 Utah gold output. Juab County produced $1,181,366 in 1910, against $1,448,096 in 1909, and Utah County $193,234 in 1910, against $276,314 in 1909. The Tintic district, which is partly in Juab County and partly in Utah County, produced $1,370,320 or 34 per cent of the gold production of Utah in 1910. Tooele County produced $721,361 (of which all except about $5,000 came from the Camp Floyd district) in 1910, against $820,486 in 1909.

The silver production of Utah in 1910 showed a decrease of 1,250,201 ounces, or 10.7 per cent. Juab County produced 3,835,062 ounces in 1910, against 3,544,918 ounces in 1909, and Utah County 1,500,625 ounces in 1910, against 2,995,658 in 1909. The Tintic district silver yield declined from 6,404,847 ounces in 1909 to 5,222,742 ounces in 1910. Salt Lake County produced 2,006,131 ounces in 1910, against 1,780,572 ounces in 1909. Of the Salt Lake County yield, the West Mountain or Bingham district contributed 1,800,410 ounces in 1910 and 1,615,394 ounces in 1909.

The silver output of the Park City mining region in 1910 was 2,571,771 ounces, a decrease of 253,614 ounces, or 10 per cent, from that of 1909.

Copper production increased in Utah 18,649,261 pounds in 1910, a larger increase than in any other of the copper-producing States. The Bingham district produced 113,725,280 pounds of copper in 1910 against 92,560,340 pounds in 1909, 71,155,740 pounds in 1908, and 45,431,964 pounds in 1907. The Tintic district yielded 8,993,036 pounds in 1910, against 5,915,669 pounds in 1909, an increase of 3,077,367 pounds. The Park City district, in Summit and Wasatch counties, produced 1,423,629 pounds in 1910, against 1,655,749 pounds in 1909.

The production of lead in Utah in 1910 was 123,324,635 pounds, valued at $5,426,284, against 148,486,463 pounds, valued at $6,384,918 in 1909. Of the 1910 output, 30.9 per cent was derived from mines in the Park City district, which produced 38,129,761 pounds, against 46,350,390 pounds in 1909. The Bingham or West Mountain district produced 30,271,016 pounds in 1910, about the same quantity as in 1909, and 24.5 per cent of the total Utah lead output. The Tintic district, which yielded 56,502,209 pounds of lead in 1909, produced only 37,553,455 pounds in 1910. This district yielded 38 per cent of the Utah lead in 1909, and only 30.4 per cent of that in 1910.

The zinc production of Utah was 16,367,104 pounds, valued at $883,824, in 1910, against 9,860,778 pounds, valued at $532,482, in 1909. This shows an increase of 6,506,326 pounds or 66 per cent. The Park City mining district alone produced 9,437,992 pounds of zinc in 1910, against 6,737,237 pounds in 1909. This district yielded in 1910 over 57.7 per cent of the total zinc production of Utah. The Bingham district was also a large producer and increased its output from 649,542 pounds in 1909 to 3,572,347 pounds in 1910. Tooele County, which produced 2,843,032 pounds, and Beaver County, which produced 513,733 pounds, were the only other counties in Utah reporting a production of zinc in 1910. The zinc in concentrates, amounting to 12,959,422 pounds, all came from Salt Lake, Summit, and Wasatch counties.

There were 183 mines producing gold, silver, copper, lead, or zinc in 1910, against 179 in 1909. Of these, 8 were small placers. The number of producing mines in the Bingham district was 31; Tintic, 40; Big and Little Cottonwood, 17; Park City, 17. The total quantity of ore sold or treated in Utah in 1910 was 6,389,398 short tons, an increase of 1,266,809 tons. The average total recoverable value per ton was $5.02 in 1910, against $6.12 in 1909. The lower average value per ton was caused by the large increase in copper ores, of which 5,417,558 tons were sold or treated in 1910. This quantity was 84 per cent of the total ore treated and an increase of 1,201,332 tons over the 1909 production of copper ores.

Of the total tonnage of all classes of ore 263,041 tons, mostly from Tooele County, went to gold and silver mills, 5,182,057 tons, of which 4,937,285 tons were from Bingham district, went to concentrating mills, and 896,834 tons were sent to smelters.

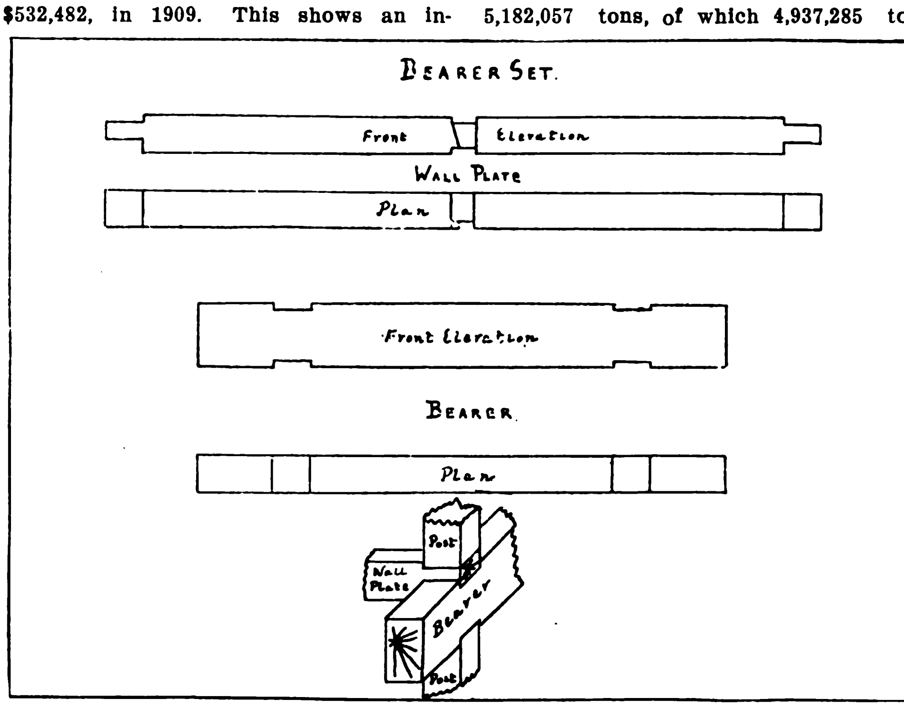

Figure 6 of Article on Preceeding Page

Consul Frederick Simpich writes from Ensenada that a $200,000 California corporation has started quarrying onyx in the Sierra Blanco peninsula, Lower California, about 200 miles south of the international boundary. Thirty men are now employed in the company's quarries and monthly shipments will be made from the landing at San Jose. This Mexican onyx lies in flat ledges close to the surface.

Mines and Methods

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CONTENTS:

Mines and Methods appreciates the implied support that its efforts of the past two years have been given by the American Mining Congress at its recent annual session in Chicago, by the adoption of the following pertinent and timely resolutions:

Resolved, That in the opinion of the American Mining Congress, the mining industry has been greatly injured by designing and unscrupulous mine promoters; that the stand heretofore taken by the Congress against this illegitimate business has done much to prohibit it; that the Congress endorses the action of the Postmaster General in his efforts to prevent the use of the United States mails for fraudulent purposes, and that it urges the enactment of legislation in all states to prevent such frauds and to increase confidence in mining investments.

Resolved, That a copy of this resolution be forwarded to the Postmaster General.

UTAH COPPER REPORT AND PERTINENT COMMENT

We are pleased to note that the Utah Copper Company in its third quarterly report for the present year continues to maintain an appearance of candor in dealing with its shareholders. This being the third and charmed number of times in which the management of this corporation has made any pretense at giving in detail such information as invariably accompanies reports of this character put out by other corporations, it is to be hoped that the practice will, in future, become a regular—even if involuntary—habit.

It will be remembered that the first attempt to supply any information regarding the quantity of ore treated, the metal value thereof and the percentages of recovery and loss of the contents in the process of treatment, was contained in the sixth annual report of the company covering the year 1910, which was given to the stockholders in the latter days of April of this year, and then, only, after we had regularly for eighteen months supplied, in accurate detail, the facts which theretofore had been withheld and guarded with scrupulous care. Of course in publishing these facts—as was to be expected—we incurred the displeasure of the promoters and beneficiaries of the "Utah deal," but we are assured that the friends of fair dealing are now pleased to see the veil of secrecy—at least aparently, though reluctantly—lifted from the gigantic operations of this corporation.

It is also gratifying to us to note that our exposure and criticism of the stupid and imbecile methods employed by the management of the company in attempts at the treatment of its ores have at last resulted in the partial adoption of the more modern and sane practice which had been in successful operation in other mills throughout the mining regions for years before the spectacular advent of the novitiates who first attempted to stage an IMITATION OF PRACTICAL MINING AND METALLURGY under the seductive title role of Utah Copper Company.

In order that our new readers—among whom are many young engineers—may more fully appreciate the progress that has been made in the operations of the metallurgical department of the Utah company, we reproduce in another column of this issue, an article entitled, "Utopian Ore Dressing Methods," which first appeared in our July, 1910, issue, and in which is graphically related the struggles endured by two ambitious young men—WITHOUT PREVIOUS EXPERIENCE—in their efforts to equip a great mining property with metallurgical and mechanical devices which they hoped would AUTOMATICALLY extract the metal values from the ores thereof and thus enable each to continue to conceal from the other, and from their employers, the fact that neither had the slightest conception of what would happen to the ore when the wheels began to turn round. The story will be found to be entertaining and instructive, and of especial interest at this time in view of the fact that at least some improvement in methods and results has been accomplished during the seven years over which the operations have extended, notwithstanding the waste of millions of dollars in the effort.

Although the destructive Chili mills have not yet been wholly abandoned—as they must be soon or late—their harmful effect has been materially neutralized by the installation of additional rolls, whereby the principal crushing is now being done, so that the original thirty-six Chili mills which at first did the fine grinding of about sixty per cent of 5,000 to 7,000 tons of ore, now grind probably not more than 20 per cent of 16,000 tons per day. And what is of vastly more importance, the management has at last discovered that by using coarse screens on these mills, and allowing a large per cent of the ore treated by them to go to the tail pond, in sizes ranging up to 1½ millimeters, instead of grinding the whole to an impalpable slime, results in the recovery of a greatly increased proportion of the metal contents regardless of included mineral lost in the coarser particles rejected as tailings. But the most important advance has been recently found by adopting the universal practice of

screening out the finished portions of the pulp after each crushing machine, so that now all material larger than 2 millimeters is screened out and returned to the rolls, the Chili mills only screening the undersize after preliminary concentration, whereby the freed mineral is extracted before the residue is sent to the Chili mills. The significance of these changes can only be appreciated after reading the story of the earlier practice, as related in the article above referred to, which will be found in another part of this issue.

As we have frequently observed in previous issues of this journal, it is only a question of the arrival of a time when these mills can be quietly dispensed with, without attracting attention, when their use will be entirely abandoned. For it must not be presumed that Manager Jackling is not NOW fully cognizant of the harmful results which has attended the use of these mills; but having been so industriously featured by the subsidized press as being second in importance only to the manager himself, one can readily see that if the fact should become known that these erstwhile—supposed—essential appendages should be abruptly consigned to the scrap heap, some doubt would naturally arise as to the integrity of the entire play, and thus not only further delay distribution of treasury shares, but even imperil the technical prestige of the entire metallurgical department.

Aside from the waste of several millions of dollars, due to the persistent use of these grinding mills after their destructive effect had become fully known to the management, a most unfortunate exigency arose, which required that the stamps which constituted the crushing plant of the original Boston Con.—now Arthur—mill be condemned, and that Chili mills be erected in their stead. This innovation was readily justified by "cooked-up" comparative tests which, of course—as designed—resulted in favor of the Chili mills; whereas, it was from the first well known that recovery of values by the Boston stamp mill at all times exceeded that of the Garfield (Magna) by more than fifteen per cent, and that the cost of operation of the Boston was lower than the Magna by an amount equal to more than one cent a pound upon the copper produced.

Manager Jackling himself is on record in a written statement in which he assumes to have made a practical test in the treatment of these identical ores —long before Utah came into existence —wherein THE CRUSHING WAS DONE WITH A STAMP MILL OF SIMILAR TYPE TO THE CONDEMNED BOSTON MILL, in which test he claimed to have made a recovery of 90 per cent of the copper contents of the ore, which exceeds by more than 40 per cent, the recoveries of the Magna mill at any time prior to one year ago, and more than 30 per cent in excess of recoveries claimed for that plant at the present time.

In a letter dated March 20, 1901, and addressed to Major J. Edwards Leckie (then temporarily located at Republic, state of Washington, as manager of a property where Mr. Jackling was employed in operating a cyanide plant), referring to the porperty which composed the original Utah Copper Company's holdings, Mr. Jackling wrote as follows:

> During the summer of 1899, I undertook some metallurgical experiments on this ore, and concentrated several hundred tons taken from the tunnels and dumps at random. The mill which I used was an abandoned FIVE-STAMP MILL, without any particular adaptation to the ore, and without appliances for making a close saving. By crushing with LIGHT STAMPS to 25 to 30 mesh and concentrating roughly over a Wilfley table, without sizers of any kind, and without special endeavor to save values from the large amount of slimes produced, I made a saving of 71.7 per cent. Some experiments made in a rough way by collecting slimes and running them over a vanner, resulted in an additional saving of about 15 per cent, or a total of 90 per cent of the copper values.

In the light of this experience, it seems inconceivable that Manager Jackling would have adopted other devices of DOUBTFUL UTILITY for crushing Utah ores without a trial of their adaptability to that service, and especially that he should have been inveigled into purchasing from the Washoe plant of the Anaconda Mining Company his first installment of Chili mills, AFTER THEY HAD BEEN CONDEMNED AND DISCARDED by that company—even though he knew that Superintendent Janney held a United States patent upon essential parts of these mills. But so it happened, nevertheless.

Having discontinued the work of replacing the stamps of the Boston Consolidated mill after substituting other machinery for five only of the thirteen "units" or sections of that plant, one would naturally have thought they would have allowed the other eight sections to remain in condition for service in case future contingencies should demand additional increase in milling facilities; or, in any event, if it should be found desirable to remove the remaining stamps, at least the massive reinforced steel-concrete foundations would have been permitted to remain where they would have provided stanch support for rolls, or even Chili mills.

But it was not to be so. On the contrary, as if in fear that some future manager—possessed of some knowledge of ore concentration—might restore the hated stamps to their foundation and thus, by their operation, further discredit the use of the Chili mills, these costly structures were drilled and charged with dynamite, the explosion of which left only a mass of twisted steel bars and scattered fragments of concrete to mark the spot—and so it remains today.

Returning to the subject of our text, the Utah company's latest quarterly report. It appears that there was treated at the two mills for the period 1,273,373 tons of ore, the average copper contents of which was 1.4829%, being 29.66 pounds of copper per ton of ore. The gross yield of copper was 25,851,456 pounds, being equal to 20.3 pounds per ton of ore treated. The cost of the copper produced is stated to have been 7.56 cents per pound and that the net profit arising therefrom was $1,150,524.44, leaving a net surplus balance for the quarter after payment of the usual dividend of $361,699.80. No information is given as to the method pursued in determining these results. It may therefore be inferred that—in the opinion of the management—such matters do not concern the stockholders. But, however this view may be regarded, the result of operations for the quarter, if stated with even approximate accuracy, should meet with general satisfaction. And whatever may have been the means by which these results were arrived at, or the imperfections which still obtain in the milling practice, we are convinced that improvements have so far progressed upon right lines—so far as the treatment of the ore at the mills is concerned—as to render it possible now—even with the comparatively low grade of ore available—to earn a substantial profit upon each ton of such ore treated, provided that the ore can be brought to the mills burdened only with such costs as must necessarily attach to rational and economic methods of extraction—such, for instance, as obtain at the property of the Ohio Copper Company, which immediately adjoins the Utah on the southeast—or even such as prevailed in the underground workings of the property of the Boston Consolidated Company at and before the time when that property was taken over by the Utah company. But, if such a consummation be impossible, because of the temerarious character of the management, THEN NO APPRECIABLE, LEGITIMATE PROFIT CAN, OR EVER WILL RESULT from the vast tonnage of ores that may be rushed to the mills, however perfect the process of treatment thereat may become.

We are moved to reiterate an oft-repeated observation of this import at this time because of an item in the report not recited above, viz:

The increased rate of stripping, referred to in our last quarterly report was, for reasons then given, continued throughout the quarter under discussion with the result that we removed, during the period, 1,595,095 cubic yards of capping, as compared with 1,395,504 for the second quarter.

The annual report for the year 1910 shows that during that year 2,814,764 cubic yards of stripping were removed, at a total cost of $1,260,666.31, being 41 cents per cubic yard of earth removed. From this we determine that the cost of removing 1,595,095 yards for the quarter under discussion was $563,988.95. The report also states that 24 per cent of the 1,273,373 tons of ore milled for the quarter was derived from underground mining. Therefore it follows that 967,764 tons were obtained by steam shovel operations. Assuming now that an amount of these stripping costs equal to 7½ cents a ton of ore obtained by steam shovels be charged to copper production—as was done for the latter half of last year—there will still remain $581,416.65 of the total stripping cost for the quarter, which sum is equal to 2.24 cents a pound upon the 25,857,456 pounds of copper produced for the quarter. If now for any reason it were desirable or necessary to include the entire cost of stripping in the cost of production, the actual cost of the copper produced would be 9.80 cents per pound —and there would still remain equipment and construction of stripping roads and many incidentals sufficient in cost to equal perhaps another one and one-half cents a pound, unprovided for.

Of course we are aware that there has been a general agreement among the members of the company's publicity bureau that the cost of removal of the surface capping is properly chargeable to capital account—as practiced by the management—and it is not our purpose at this time to repeat our previous charges of inconsistency in this method of disposing of mining costs, but rather to propound a friendly inquiry of adherents of this practice: Let us suppose that the Utah company had already divided all of its authorized capital stock among its existing shareholders, and was without corporate power to further increase its share capital. Would the management be justified in compelling the shareholders to abandon the property because of failure to realize from sale of the mine's products the cost of production by continuing the means and methods employed in the extraction of the ores when, by adopting methods in use in other mines, a substantial profit could be gained?

Let the outside shareholders, if there be any, answer.

OCTOBER OUTPUT OF UTAH

The Utah Copper Company reports the yield of copper for the month of October, 1911, at 8,660,729 pounds, which compares with a yield of 9,283,810 pounds for September month, a falling off of 624,642 pounds. No statement is made in the brief report received as to the number of tons of ore treated for the month, but we are able to state that the amount was largely in excess of any previous month, being approximately 514,000 tons, or an average of over 16,500 tons per day for each of the thirty-one days of the month. Deducting five per cent for moisture, which is probably high, the total number of dry tons treated was a little over 488,000, equal to a daily average of 15,750 tons. The yield of copper per ton of ore was approximately 17.72 pounds and compares with an average yield of 20.30 pounds per ton of ore treated for the third quarter of 1911—as recently reported—which shows a falling off in production of copper for October of 2.58 pounds per ton of ore treated, being equal to nearly 13 per cent. This shows that the average grade of ore treated was slightly less than 1.29% copper, and compares with 1.4829, the average for the third quarter of this year, as shown by the official report. This deficiency is equivalent to about 1.4 cents per pound in addition to the cost of copper reported for the last quarter, and indicates that the next quarterly dividend—if earned at all—will be saved by a very narrow margin. This serves to emphasize the fact frequently mentioned by us that as the rush of tonnage through the mills is increased, a corresponding dimunition of values in the grade of the ore follows.

AN ECHO OF THE CHILI MILLS

An exhaustive series of tests is being made in the concentrator at McGill, to determine more precisely the saving made and and the amount of losses in tailings and what improvements can be made to increase the saving and profits. Four sections of the mill are being used to make the tests which will be thorough in every detail.

For some months the company has been experimenting with the slimes and now has eight tables on which nothing but slimes are treated and which are being operated successfully. With them the company is making a good profit and the management believes that all the slimes can be handled by the same or a similar process with the result of increased profits from the operations. At present the losses in slimes amounts to $100,000 a month, or about a million and a quarter a year.—Ely Expositor.

This company was the first of the porphyry group to be betrayed by the Utah Copper Company's subsidized press into the employment of Chili mills for reduction of their ores for concentration. Miami soon followed the trail of the "bell-wether," with Ray Con. a close third; and now Chino is being pushed into the line just in time to see Ray wobbling in the maverick class pending a rearrangement of her internal complexities.

The loss of a hundred thousand dollars worth of copper a month by the Utah company would not create a ripple in the financial affairs of that corporation, as the manager has frequently said in like contingencies: "Copper is the cheapest thing I've got." But with Nevada Con. the situation is different, as it only had about forty million tons of ore to begin with. It therefore behooves the management to endeavor to devise means for stopping the small leaks at least; but it is not probable that they will be permitted to look in the direction of the Chili mills for the cause of trouble for some time to come.

At the Miami we understand that Doctor Channing is proceeding to try out the Harding ball mill as a substitute for the Chilians, which are to be retired. By the way, we do not understand why Doctor Channing failed to avail himself of the advantages to be gained by use of steam shovels for stripping and mining Miami ores, as suggested by us several months ago, at which time we showed that by adopting the system of averages in use by the Utah company—as explained by the manager in his late annual report—the capping of the ore-bodies could be easily reduced to a mere film and thus render conditions ideal for steam shovel operations. Perhaps the professor may intend to adopt, instead, Manager Jackling's method of "breaking down the capping" by first removing the ore from directly beneath it and thus cause the capping to cave into the empty stopes and "break itself," which of course renders conditions for steam shovel removal of the capping quite ideal. But we think the system of REMOVAL OF THE CAPPING BY "AVERAGES" preferable under conditions which prevail at the Miami.

WORDS OF APPRECIATION

Realizing the value of the work of Mines and Methods and appreciating the benefits that will sooner or later accrue from the campaign being waged by this journal against the deceptions practiced by some of the big corporations and their publicity agents, a prominent eastern engineering and investing firm pays us the following compliment:

"We have read with a great deal of pleasure your last issue of Mines and Methods, and we have come to the conclusion that regardless of how sore you may have made your enemies, that at any rate they cannot but admire your absolute fearlessness and the able manner in which you nailed them to the text and hold them up in full view, in broad daylight, and so persistently chase them out from the bushes and lumber piles and heaps of manipulated figures under which they seek to hide themselves."

ENCOURAGING COMPETITION

Much has been said and written since the United States Supreme Court decisions against the Standard Oil and Tobacco trusts, regarding the justice or injustice of the actions brought by the government against the United States Steel Corporation, or Steel Trust, as it is called. The weight of evidence thus promulgated has been and still seems to be that the Steel Trust is a "good trust" and should not be harrassed by the government. This was almost pathetically pleaded in a recent talk by Chairman Garey to the heads of the various subsidiary organizations and the idea was quickly promulgated by the corporation's publicity agents. The Engineering and Mining Journal of the 11th instant approvingly quotes the opinion of "a New York commercial house" on the subject. This "opinion" ends with the following declaration:

"The United States Steel Corporation has always been tolerant of competition. It has encouraged competition. It has avowed and pursued a policy of live and let live in trade, and the remarkable result is that at the present time all of the big independent steel companies, instead of being against the big company, side with it."

It is not the purpose here to question the right of the Steel Corporation to continue to exist and do business in its usual way. The United States Steel Corporation is probably one of the best "trusts" that was ever formed, but there is no question that the "New York commercial house" is off wrong when it says that it has always been "tolerant" and that "it has encouraged competition" and also "pursued a policy of live and let live." Utah and Colorado are each so remote from the seat of all power behind the Steel Trust throne that business interests in these far western states would seem not to be in a position to know much about the manner in which the greatest corporation on earth accomplishes its ends; but they have both felt the grip of its mailed hand and both states will have reason to remember the acquaintanship for years to come.

The subject is too deep a one to touch in more than a superficial way and features that properly belong to the Colorado side may be left to Coloradoans to handle. But to show how keen the Steel Trust has been to encourage competition and display its spirit of tolerance and live-and-let-live disposition, it is only necessary to tell what happened here about eight years or so ago.

At that time a deal involving the sale of the iron deposits of southern Utah—or a large proportion of these vast resources—had been rounded into shape and the state was congratulating itself upon the outlook for the early establishment of great steel works, rolling mills, blast furnaces and the numerous other enterprises that would follow the opening and mining of the Utah iron deposits. There was no suspicion of fakery in the undertaking and it really looked as though the powerful Steel Corporation would soon find real competition on the far western slope of the continent. Options involving thousands of acres of iron had been secured at prices aggregating a total of more than $1,000,000 and a great deal of money had been used in developing the deposits, securing patents and otherwise getting things in shape for the final closing of the deal and preparation for the building of the plants that those behind the undertaking had already planned. The owners of the mines had received a first payment that amounted to nearly a quarter of a million dollars and a second payment, approximating $500,000, was just coming due when the whole business was dropped—dropped so suddenly and with such little concern on the part of the promoters that Utahns could hardly believe their senses.

This deal was being promoted by P. L. Kimberly and F. H. Buhl, of Chicago—the former now deceased. They were well known in iron and steel circles and both had cleaned up fortunes through turning in properties of their own when the Steel Corporation was formed, or following its formation. Mr. Kimberly had stated that both foreign and domestic capital was behind the move to begin the utilization of Utah's fine iron deposits and the impression was general at the time that some of this country's iron masters, associated with German talent, was the combination that would soon be taking care of the iron and steel business in the far western part of the United States and in the countries that might be dealth with through the harbors of the Pacific.

The time arrived for the second payment to the owners of the mines and word had been received that Mr. Kimberly would be here on time to make the payment—no one suspected a hitch of any kind. The night before payment was to be made Mr. Kimberly arrived and a representative of one of the Salt Lake papers sought him out and asked that he be permitted to announce in the morning—as a "scoop"—that the deal was to be carried through as previously planned and understood by everybody. What did Mr. Kimberly reply?

"I have no objection," he said, "to your pulling off a scoop on your competitors; but I am afraid the news will be altogether unwelcome. I am going to notify the owners of the mines in the morning that the deal is off; that the money already paid is theirs and that the papers in escrow may be taken back. That is all there is to it."

Questioned as to what the trouble was, Mr. Kimberly replied that all he could possibly say for publication was that he **"had agreed to be good;"** that he and his associates had been well repaid for all the time they had lost and expenditures they had made. That, in brief, explains what happened and that is about all that the public has ever learned about it.

Before Mr. Kimberly dismissed his interviewer, however, he confidentially explained that both he and Mr. Buhl had done lots of business with the Steel Corporation; that their business relations were most friendly; that every detail of the Utah deal, with the exception of the names of the men behind it, had become known to the trust officials; that they had declared that the Utah iron mines must not be developed for years to come; that he (Kimberly) must drop the deal and name his price for doing so. That he said, he had done, and that was what he meant by saying he had agreed to be good—and, incidentally, THAT ILLUSTRATES ONE POINT IN HOW THE STEEL TRUST "HAS ENCOURAGED COMPETITION."

"WHAT THE MATTER IS"

Under the above caption Collier's National Weekly of the 18th instant says:

Most of the captains of industry (including Mr. Charles S. Mellen, president of the New Haven Railroad) thinks it is politics and a trouble-making administration. All the promoters and exploiters, and most bankers of the sort who are called financiers, say it is agitation, demagoguery, muckraking—all the same sort of thing. (There's a solid race of old-fashioned bankers, the backbone of Wall Street, who know better.) If one of those now under suspicion may be granted two minutes in court, we should like to venture the suggestion that the state of facts illustrated by the following figures has something to do with it. (We start with 1904 because that is the year Mr. Mellen came out of the West to become president of what was then one of the most conservatively capitalized and most stable Eastern railroads):

In 1904 the net income of the New Haven and Hartford Railroad was	$ 14,030,134
The capitalization (liabilities) that year was	136,436,893
In 1911 the net income was	28,255,160
The capitalization (liabilities) in 1911 was	492,118,175

To put this more briefly and roughly: in seven years the net income grew from $14,000,000 to $28,000,000; in the same seven years Mr. Mellen increased the debts and obligations from $136,000,000 to $492,000,000, or

1904 to 1911, **earnings** increased **100** per cent.

Same period, **debts and liabilities** increased **300** per cent.

Previous to 1904, for every one dollar of income there were ten dollars of liabilities; during the last seven years, every time the road earned a dollar extra Mr. Mellen piled on nearly twenty dollars of stock and bonds.

We think business will just have to pause and get its breath until the earnings catch up to something like the same relation to debths that they had ten years

ago. We don't know anything in nature or political economy that will avoid this process or ameliorate it. And between Mr. Mellen and us, we want a fair umpire to say who caused the trouble.

N. B.—While we don't hesitate to put the example of the New Haven forward as typical of railroad and industrial corporations generally during the last ten or fifteen years, we don't want to say that it is universal; the Louisville and Nashville Railroad, for example, under President Milton H. Smith, has actually cut down its capitalization during the past ten years—upon which premise we venture the prediction that the Louisville and Nashville will have smoother sledding during the next few years than Mr. Mellen's New Haven.

Our friends who of late have been industriously rumaging the files of subsidized mining and financial journals in vain search of an intelligent and honest explanation of the cause of public indifference to the many "glittering opportunities" to amass great wealth by investment in the shares of mining corporations that are being offered—without takers—may find a solution of the loss of public interest in these ventures by a careful comparison of the "Mellen methods" with those of promoters of a number of the "porphyry" copper mines whose shares and bonds are being hawked in the market places of the world with such feverish persistence. Evidently these "matchless ones" have discovered that faked and "washed" sales upon the stock exchanges do not fool the same people all the time.

THE COPPER HANDBOOK

We acknowledge receipt of a communication from Mr. Horace J. Stevens, author of the Copper Handbook, in which he says:

"I am in receipt of your issue for October, 1911, referring editorially to the Copper Handbook, in which you make the following statement regarding the description of the Utah Copper Company, appearing in Vol. X of the Copper Handbook:

> As the story looks and reads, it is quite evident that "circa" all the data, as well as much, if not "circa" all the language in the recital, was supplied by the Utah Copper Company's own publicity bureau. But then—it costs money to issue works like the Copper Handbook.

"I beg to advise you that the foregoing statement that I have quoted from your October issue is absolutely and unqualifiedly false. It is not the case that 'circa' all the data, as well as much if not 'circa' all the language of the recital was supplied by the Utah Copper Company. The Utah company furnished me reports on my own blanks, of the sort that are sent by me to every live address of every live mining company that I can locate. The company also furnished me copies of its official annual reports and nothing further. ***."

Upon a careful comparison of the language quoted from Mines and Methods by Mr. Stevens—of which he so violently complains—with his own statement, as above quoted from his letter wherein he explains the manner in which he procured the information referred to regarding the Utah Copper Company's operations, we confess that the only perceptible difference which we are able to discover lies wholly in the fact that, in respect to the data supplied by the Utah company, (other than that contained in its several official reports), it was made UPON BLANKS FURNISHED BY MR. STEVENS FOR THAT PURPOSE. Not being aware, at the time, of the fact that Mr. Stevens had furnished the paper upon which the Utah Copper officials transmitted such statements as they desired to have published in the Handbook, we of course failed to give him the full measure of credit to which he now appears to have been entitled. For this unintentional omission we beg to tender a most earnest apology. At the same time we are strongly inclined to the belief that our playful use of Mr. Stevens' pet term, "circa," is the real cause of his displeasure, and for which indiscretion we tender our sincere regrets, with assurance that in future we shall respect his exclusive privilege in the use of that ONLY TERM which appears to indicate "any old thing" except the REAL THING.

BELLINGER TRIUMPHS

The October issue of the London Mining Magazine, in its "Review of Mining," has the following comment on the Great Cobar of Western Australia, the mines and works of which are under the general management of H. C. Bellinger, who quit the engineering staff of F. A. Heinze about four or five years ago to accept the offer of the Great Cobar corporation. The item, it will be noted by our Butte readers, shows that popular "Nick" Treloar, of Butte, is now mine superintendent and working in complete harmony with Mr. Bellinger who, according to periodical reports from Australia, has had quite a time in whipping Great Cobar affairs into first-class shape. The friends of Mr. Bellinger will be glad to know that he has triumphed:

> Conditions at the Great Cobar are improving. The weak point was underground, the workings not having been opened up so as to yield the proper mixture of ore required for economic smelting. This weakness was accentuated by the purchase of the Cobar gold mine, which gives a highly silicious output. The Chesney mine, which also belongs to the Great Cobar company, is developing satisfactorily, and the old concentration plant is being re-arranged with a view to eliminating the excess of silicious material in the form of slate. Mr. Nicholas Treloar, formerly at Butte, is now mine superintendent and worthily supplements the skilful metallurgical work of Mr. H. C. Bellinger. Rumors of the latter's resignation have now ceased.

EDITORIAL NOTES

It is several years since the price of silver was as good as it is at the present time. Conditions in India and the hording of silver as a result of the revolution in China, makes it look as though a prosperous period was ahead for the silver-lead miners.

This is a wonderful country of ours. Just as we begin to growl at Germany for placing restrictions on exports of potash the news is flashed out to the world that great deposits of this valuable fertilizing substance have been discovered at home. Nevada promises to make up for anything lost to us through the action of Germany, if the government conservationists will keep hands off for a short time.

Better and better reports are continually coming from the comparatively new gold camp of Jarbidge, in the northeast corner of Nevada, and it now seems reasonably certain that, within another year or two, it will be a large and important producer of the yellow metal. Unlike most of the camps discovered during the past eight or ten years, Jarbidge is not parading or relying upon tales of "fabulously rich" ores and "sensational" strikes to back its claims to recognition. The best news that is brought out by engineers is to the effect that many ledges are being developed that will produce good tonnages of $10 to $35 rock. The physical construction of the country, it is claimed, is such that most of the mining can be done through tunnels. There is an abundance of water for milling and all other purposes, while the hills and canyons are prolific sources of timber, with mahogany and other hard woods in abundance for fuel supplies. A late arrival from the district says the camp will boast of a number of good milling plants within another year, when operating protfis will be substantial and continuous for many years to come.

Once again the local newspapers are telling of the railroad that is going to be built from Salt Lake into the Deep Creek mining region. Times almost without numebr has this much-needed road been constructed upon paper, but that is as far as it has gone. When the Western Pacific road was built everybody felt sanguine that it would cut farther to the south and go into Nevada through the Deep Creek pass rather than fifty or sixty miles to the north, where there was practically no tributary business. Later it was promised that the Western Pacific would build a branch line south from Wendover—and it may possibly do so yet. One thing is certain, and that is that the

Deep Creek region is too well laden with mineral to go long without transportation facilities. If the Western Pacific does not provide it, someone else will. Maybe it will be the Salt Lake, Los Angeles & San Pedro, which could execute a splendid business coup by cutting west from Ironton through Dugway, to Gold Hill, Ibapah and on to Ely, Nevada, and probably through to Goldfield. If that is done, the Western Pacific will operate about 300 miles of practically tributeless road. Looked at in this light, it seems most likely that Deep Creek will get a road before long.

The "high line" of the Salt Lake, Los Angeles & San Pedro Railroad Company through the Meadow Valley Wash has been finished and turned over by the contractors to the operating department of the railroad company. This high line, which stretches along the precipitous, craggy mountainside well above the water grade in the bottom of Meadow Valley canyon, is conceded to be a magnificent piece of engineering and will permanently relieve the company from danger of floods and wash-outs in the future. In presenting the news concerning the completion of the task, the account of the Salt Lake Evening Telegram opens with the following data concerning the achievement:

Length, seventy-six miles.
Cost, $5,000,000.
Time of building, thirteen months.
Ten tunnels, aggregate length 5072 feet.
Twenty-four bridges, solid steel in concrete abutments and piers sunk to bed-rock.
Roadbed further protected by concrete retaining walls and riprapping of huge granite blocks extending for miles.

This cost of $5,000,000 for SEVENTY-SIX MILES of road in a hot, dry, barren region 300 miles from nowhere, in any direction, is not a bad record as compared with the widely heralded TWENTY-MILE LINE, costing over $5,000,000, of the Utah Copper Company. Just think about it a little. One cost a little more than $65,000 a mile—the other, $250,000 a mile.

COPPERETTES

A mine manager may be thoroughly honest and of good general ability; but, his judgment may not be good, and he may be lacking in the training and experience necessary for him to "make good" in the position he holds. A trial of a few months should demonstrate his executive ability, his fitness for the position; and, if it is found that he is lacking in these qualifications, he should be fired, no matter if he is in charge of a big mining enterprise.—Salt Lake Mining Review.

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Now, see here! If we thought for a moment that the writer of the above had in mind any one of OUR friends we should feel inclined to scold him and send him to bed without his supper.

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No feeling of friendship, nor fear of offending relatives and friends, should stand in the way of making a change in mine management when it is clearly evident that a change should be made. To hesitate in this matter often means the absolute failure of the enterprise.—Salt Lake Mining Review.

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A Paris cable says that negotiations are in progress for the listing on the Parquet department of the Bourse a number of American industrial stocks, notably those of the Ray Consolidated Copper Company and the Chino Company.—New York Curb.

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Ray Consolidated and Chino are being touted as the two next biggest things in the copper world to Utah Copper—which is certainly a star of the first magnitude when viewed in the scintillating, dazzling light of extravagant application of borrowed money—so it is only natural that the big backers and promoters of Ray and Chino should try and get the French to participate with them in these "good things," also. All three of these stocks have advanced so sharply in price during the past few weeks of acute distress in other market offerings that a sober, wondering world has gasped in contemplation of the spectacle.

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A man named Spencer a year ago conceived the idea of building a ten-story office building in connection with the late D. H. Moffatt. It was to be named the First National Bank building. Moffat was president of the bank of same name. Bank takes a lease for a million years or less at rental to pay big interest. Also bank takes $200,000 bonds. Building to cost a million dollars. Bank takes its bonds. Dear Public takes balance of $1,100,000. Promoter gets the $100,000 cash extra besides commission. Moffatt also controlled the International Trust Company. Turns his $200,000 bonds over to them. All promptly unloaded on public, while Spencer sells his million by mail, erects the building. Meantime Moffat dies. Building erected. Interest period on bonds comes due. Very few tenants. No interest money. Dear bondholders try to collect. Threaten foreclosure. Nothing doing. THEY ARE NOT BONDS, declare the Trust Company, through its V. P., Theodore Smith, a promoter formerly of Boston. They are merely preferred CUMULATIVE shares—profit sharing. Now the post office inspectors are trying to fathom the mystery, and matter is hushed up through Senator Guggenheim.—Denver correspondent in New York Curb of Nov. 4th.

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That suspicion of scandal should be attached to the First National bank of Denver so soon after the purchase of control by what is termed the "Utah Copper crowd" is indeed unfortunate and Mines and Methods, while standing in trembling suspense, hopes that nothing further will develop to put the big Den- institution or its newest sponsors in a bad light.

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Several hundred men on the Utah Copper construction gang have been laid off. The work at the Arthur mill will be discontinued for the present, and the officials are conferring with Manager Jackling as to plans for curtailing expenses for a few months. The meeting is being held in Denver. The two mills of the company have a greater capacity than is being supplied by the Bingham mines at present, and until the metal and general business conditions are improved a curtailment in operations will be observed. —Item from Salt Lake in the Mining and Engineering World of Sept. 23.

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Notwithstanding the action mentioned above the Utah Copper Company, we are reliably informed, opened a new "construction" account in its books October 1. So far as known nothing has happened in the line of new work or the resumption of rebuilding the remaining seven "wrecked" and unproductive units of the company's Arthur mill, so the opening of this "construction" account must be with a view of accomplishing some other purpose. We have it from an inside source that the average copper contents of the ore treated is now crowding 1% so closely and costs are so persistently climbing in consequence, that something must be done to provide a reasonable excuse for the showing and to provide a further excuse for seeking more "new money" through another sale of treasury shares. That lots of "new money" is soon going to be needed is a cinch.

LEACHING APPLIED TO COPPER ORE*

TWELFTH ARTICLE REVIEWING RESULTS ACCOMPLISHED, WITH SPECIAL REFERENCE TO TREATMENT OF COPPER SILICATES

By W. L. AUSTIN.†

Through th courtesy of Mr. Paul O. Wels* the following description of a leaching experiment has been made available. The operations to be described were carried out at the Keystone mine in the Miami district, Globe, Arizona, in 1905, and the details are thought to present points of interest to those engaged in developing this branch of industry. However, as Mr. Wels remarks, this seems to be another case of experimental work insufficiently exploited to produce results of a definite character.

The leaching tests conducted at the Keystone mine were under the direction of Mr. John Herman**, who has kindly placed his notes at the disposal of the writer. Mr. Herman expresses the opinion that success might have crowned the effort made to introduce the process, had it not been that continual stoppages were caused by the inefficiency of the apparatus employed. There were troubles brought about through leaky vats, and through the means first adopted to produce circulation of the anode liquors. As originally constructed the plant could be operated only for an hour or two at a time, and some dozen attempts were made to get it into satisfactory operation during the month that the tests were in progress. Alterations were being introduced to overcome the mechanical difficulties encountered, when operations were suspended for reasons which are said to have had nothing to do with the merits of the leaching process. From a chemical standpoint the tests were considered wholly satisfactory, the results upon a working scale substantiating original laboratory experiments.

It would seem superfluous to criticise the policy of abandoning experiments when obstacles were encountered in the initial stages, were it not for the fact that instances of the kind are common, and that much money is wasted through loss of courage in the beginnings of undertakings of this nature. It is not to be expected that a small, perhaps inadequately equipped plant, will achieve success from the moment of its installation, especially when an ore is being subjected to treatment which has not previously been tested by the process employed. There must inevitably arise defects in apparatus which only make themselves apparent when the appliances are tried upon a working scale, and this is particularly the case when the process involves changes in aqueous solutions under operating conditions. Unforeseen developments may arise producing complications a remedy for which calls for considerable mechanical and chemical ability on the part of the engineer in charge. Provision should be made for such initial difficulties in order that investors who put their money into such enterprises may be properly protected.

When it has been demonstrated that the fundamental principles involved are sound, it is only through intelligent persistence that success can be attained in the application of any metallurgical process under novel conditions. It will be remembered that in the early days of Leadville, Colorado, when such docile ore as the heavy lead-carbonates were being smelted, the metallurgists of that day found considerable difficulty in keeping their furnaces in blast for twenty-four consecutive hours, and only the high treatment charges prevented a number of financial wrecks. One of the smeltermen (who afterwards made the greatest financial success of the district) "froze" his furnace up daily, and spent his nights in "barring out." Innumerable small metallurgical works of all descriptions have been from time to time erected in the United States with only sufficient capital to get them started, and when difficulties were encountered, were abandoned without a real effort being made to accomplish the purpose for which they were built. The Keystone plant was evidently an example of this kind, but often it is possible to derive considerable information from descriptions of incompleted undertakings.

Miami District, Arizona. Keystone Mine in Middle Distance

The Keystone ore-deposit presented on the surface the appearance of a white porphyry traversed by veinlets of chrysocolla (copper silicate), accompanied by malachite in small quantities and some chalcocite in the lower workings. One of these veins averaged a foot or more in thickness and was for some years the object of exploitation,

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the selected ore being sent to Canyon City, El Paso, and elsewhere. The ore shipped assayed as high as twenty odd per cent. The porphyry gangue was almost free from iron and lime, but contained considerable alkali silicates. The metallurgical problem as presented amounted to leaching chrysocolla.

The experimental leaching plant was designed to have a capacity of 1500 lb. copper in 24 hours, when using a modification of the Hoepfner* process. This method was considered to possess the most promise under prevailing local conditions.

Previous to deciding upon the adoption of the Hoepfner process, laboratory experiments were made to test the qualifications of various leachings methods, among these lixiviation with sulphuric acid. It was found that the copper could be readily dissolved out of the ore when dilute sulphuric acid was used, and that only a small excess of acid was consumed by the other bases present, if the pulp was not left too long in contact with the acid solution. Using a solution containing ten per cent sulphuric acid, 97 per cent of the copper could be removed from finely crushed calcined ore, and 95 per cent from coarsely crushed similar material. When copper silicate was calcined at a dull-red heat in an oxidizing atmosphere, it became black and friable, and the copper went readily into solution in sulphuric acid. Although a good extraction could be made in this way, the method was considered impractical because of the high cost of acid, and of the iron** necessary to precipitate the metal from the solution. An additional objection was the high refining charge attached to the treatment of the cement-copper. Furthermore, as the decomposition of the pulp was fairly complete, accompanied with gelatilization, it was thought that this feature might lead to complications in the subsequent separation of lixivium from tailings.

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* For description of the Hoepfner process see Mines & Methods for May, 1911, pages 212-214; and for June, 1911, pages 243-244.

Hoépfner's process was repeatedly tried out in Europe, and particularly at Weidenau and Papenburg. The principal difficulties encountered in attempts to introduce the process, (as also with Siemens & Halske's method), are said to have been in the extraction department. The ore had to be ground very fine, and treated with hot lixiviant under agitation, and nevertheless, even with these precautions, when tested on a commercial scale the extraction was insufficient. Iron went into solution and caused trouble; it was difficult to find suitable material for the construction of the extraction-barrels; washing out the slimes and their disposition, was not an easy problem; proper roasting of the ore was hard to accomplish; and the materials used for anodes and diaphragms were very unsatisfactory. Every change in the composition of an ore necessitated modification in the method of treatment. After many trials, attempts to introduce the process were abandoned, in spite of the attractive features it presented. However, what has been said applies to sulphide ore and not to copper silicates.

** A number of years ago experiments were made at Pittsburgh looking to the production of iron by the so-called direct process in competition with puddled metal. The iron ore was ground and mixed with powdered charcoal, and placed in sheet-iron cases. The cases were put into an ordinary puddling furnace and fired in the usual way. After a sufficient lapse of time the glowing lumps were removed from the furnace and treated the same as puddled iron. The resulting bars had the same appearance as regulation puddled metal, but the method did not prove economical. The process suggests, however, a means of obtaining iron for precipitating purposes under conditions favorable for its application.

Other lixiviation methods were also experimented with, the ammonia process being one of them. An ammoniacal solution (ammonia water and ammonium sulphate) showed very slight action on copper silicate: better results were obtained when the liquors were heated and agitated. Ammonium sulphate extracted more copper than ammonia alone. A mixture of ammonia, ammonium chloride, and sodium carbonate dissolved only ten per cent of the contained copper in three days. Ammonia was found to attack finely divided metallic copper readily, but solution was incomplete.

The Hunt & Douglas process (ferrous chloride) was also tried. A ferrous chloride solution had no appreciable effect upon the uncalcined ore, but with material which had been through the kiln the extraction was fairly complete. When both iron and copper were present in solution it was found that ferrous chloride was changed to ferric by the cupric chloride, with corresponding reduction of the latter compound to cuprous chloride. From calcined ore containing cupric oxide ferrous chloride solution extracted 47 per cent of the contained copper in two hours in the cold: when heated, 67 per cent was taken out in the same time.

Leaching with any acid per se of course involves the use of fresh lixiviant with each ore-charge treated: once salts are formed, there is no regeneration of the acid economically practical by chemical means alone. In most cases when it has been attempted to purchase commercial acid for lixiviation purposes, without regeneration of the lixiviant, the cost of the acid has proven to be an insuperable obstacle to leaching low-grade ore, and the management of the Keystone undertaking wisely determined to employ a method which would permit of regenerating the solvent liquors, and at the same time yield marketable copper.

In the Hoepfner process cupric chloride is the active factor, and in the tests made on Keystone ore previous to deciding upon the best method for use, it was found that this reagent had no appreciable action on raw copper-silicate ore. It was, therefore, determined to subject the ore to a preliminary treatment to ascertain if the metal could not be brought into a form in which it could be dissolved by the proposed lixiviant. To accomplish this purpose the ore was crushed to about three-quarter inch, and charged into a kiln arranged so that reducing gases could be introduced through openings in the side, the intention being to reduce the copper silicate to metal before subjecting the material to the action of solvent liquors.

The kiln employed was constructed with a sheet-iron casing, lined with fire-brick. The casing was necessary to prevent the leakage of gases through the bricks. The structure was fourteen feet high, eighteen inches by thirty-six at the tuyere openings (four in number) and widened towards the top. Reducing gases were obtained from a small producer placed contiguous to the kiln. Coke was burned in the producer, and towards the end of the experiments oil was introduced into the top of the producer, and volatilized for the purpose of economizing on coke, oil being the cheaper material. Air was supplied to the producer by a small pressure blower.

The ore column reached about six feet above the tuyere openings which were seven feet from the top, and after treatment the charge was removed through a gate in the bottom of the kiln. A careful regulation of the temperature was necessary to prevent clinkering.

The reactions which took place in the kiln were: (1) decomposition of the copper silicate, copper oxide and silica being produced while the color of the ore changed from blue to black. (2) By further action of the carbonic oxide gas upon the cupric oxide the latter was reduced to spongy metallic copper. The reduction was fairly complete, almost all the copper finally appearing in the metallic state.* When the operation is carried out at a low temperature the copper produced is powdery and difficult to concentrate: at high temperature it is "tougher" and may be concentrated by fine grinding and panning.

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* Heating calcareous copper ore with carbonaceous substances to reduce the copper to metal, and then separating the lime by an air-blast, was tried about the middle of the last century (Bischoff, Oesterreichische Zeitscrrift fuer Berg-und Huettenwesen, 1860, N° 5; Porth, Berg-und Huettenmaennische Zeitung, 1860, page 419). Oxide ore was also broken into pieces about the size of a walnut, heated either in a shaft-furnace or a reverberatory to produce metallic copper and lime, and then the latter was removed by treatment with water.

John Herman, in a paper treating upon mine fires, (Mining Reporter of March 19th, 1903,) states that the means employed by him to extinguish a fire in the United Verdi mine was as follows:

"A receiver five feet in diameter and eight feet in height was constructed and filled with roasted ore from the heap. This ore consisted of oxidized ore-lumps the size of a man's fist or larger. The hot gases of the burning fuel (coke) were passed through this receiver from top to bottom. The carbon monoxide present reduced the ferric and cupric oxides to ferrous and cuprous oxides being itself oxidized to carbon dioxide:

$$Fe_2O_3+CO=2FeO+CO_2$$
$$2CuO+CO=Cu_2O+CO_2.$$

The reaction was carried further under the influence of heat and much carbon monoxide:

$$FeO+CO=CO_2+Fe$$
$$Cu_2O+CO=2Cu+CO_2$$

It was found that all the copper present could easily be reduced to metallic globules of some size, while the iron parted with its oxygen with difficulty, leaving porous metallic iron. In practice very little metallic iron was formed. The copper could easily be concentrated."

Referring to a patent isued to N. S. Keith for a process of separating metal from its gangue, which consists in grinding the ore with carbon, heating the ground mixture in an atmosphere of reducing gases to the fusion point of the particles of metal, and then submitting the mixture to mechanical treatment, John Herman remarks (Engineering & Mining Journal, July 4th, 1903,) that with all such processes there is a difficulty in preventing the oxidation of the copper. He therefore suggests that a furnace be divided into two compartments, one for fuel and the other for ore, and that steam be injected into the burning fuel to form a reducing atmosphere. The hot gases could then be passed through the ore into the other compartment, thus attaining the full value of the combustible both from a reducing and calorific standpoint. Mr Herman states further that he has found no difficulty in reducing copper on a large scale in this way.

N. S. Keith, according to a paper published by him in the Journal of the Franklin Institute, "devised and put into successful operation" the process briefly outlined below. Mr. Keith states that when copper carbonates are exposed to a red heat they are decomposed—the oxides of carbon being freed as gases and cupric oxide is being produced. If the atmosphere in which this decomposition takes place be a reducing one, then the copper is reduced to metallic condition. If the temperature be high enough to melt copper, small metallic globules will result. Chalcocitic ore after roasting may be treated in the same way.

To carry out the process Keith proposed a shaft furnace about twenty feet in height, constructed of red brick with a fire-brick lining. Powdered rock, powdered coal, and producer gas were introduced at the top of the furnace through many holes provided for the purpose. At the bottom of the furnace was an incline extending into a dust-collecting chamber, which chamber connected in turn with another shaft. This latter shaft was filled with pieces of coke, or small stones, and was used as a collector. It was provided with a sprinkler to assist in retaining the dust and fumes. An exhaust fan drew the gases down the first shaft and up the second.

The operation consisted in feeding a comminuted mixture of pulverized rock and coal (three per cent coal) continuously into the top of the first shaft, which resulted in the reduction of the copper and precious metals to metallic globules. These collected in the loose gangue at the bottom of the shaft. This material, together with the condensed fume from the second shaft, were then treated on concentrators to separate the heavy metals.

The fuel used in the preliminary treatment amounted to four per cent of the weight of the ore.

An effort was made to utilize the unconsumed carbonic oxide in preheating the ore, and for this purpose a second set of tuyere-openings was introduced between the lower set and the top of the kiln. Air was blown into these openings from the same apparatus that furnished the supply for the producer. This intended economy did not work satisfactorily**, probably because the temperature was too low, or the gases too dilute, to permit combustion under the conditions specified.

The Keystone raw-ore treated in the tests to be described, contained between three and five per cent copper. It was crushed in rolls before being brought into contact with the lixiviant. The time required for leaching was found to be proportional to the degree of comminution to which the ore had been subjected. With thirty-mesh material the copper could be extracted in about two hours, leaving only 0.1 per cent of the metal in the tailings.

As an illustration of the effect of degree of comminution upon the amount of copper extracted from calcined copper silicate ore (20% copper), the following is of interest. The ore used in these tests was screen-sized after calcining, without being crushed.

Period Leached.	Mesh.	Extraction. Per Cent.	Mesh.	Extraction. Per Cent.
One hour	20 to 40	75	....	....
Two hours	....	....	20 to 40	91
One hour (crushed)	20 to 40	82	....	..
One hour	40 to 60	92	....	..
Two hours	....	....	40 to 60	97.5
One hour (crushed)	40 to 60	95	....	....
One hour	60 to 80	98.2	....	....
One hour	80 to 100	99.5	....	....

The above results were obtained using a two per cent cupric chloride solution, which was estimated to contain the theoretical amount of reagent necessary to effect solution. As shown in the table, there was an improvement in the percentage of extraction when the material had been crushed after calcination, over that obtained when uncrushed ore was treated.

The strength of solution above theoretical requirements used for lixiviating, it is said, did not effect either the amount of copper extracted nor the time. The cupric chloride lixiviant acted on the calcined ore when only 0.1 per cent of copper was present in the cupric form.

** The introduction of gases into shaft-furnaces with a view to their combustion, is impractical, because a certain amount of open space is necessary for commingling with air, and this space is not available under conditions existing in the apparatus indicated. In other words, to burn gases effectively an adequate combustion chamber must be provided.

The lixivant used in the Keystone tests contained about five per cent copper in the form of cupric chloride, and the presence of twenty per cent sodium chloride* was found necessary to hold in solution the cuprous chloride produced. A solution containing 200 grams per litre of sodium chloride was found to hold dissolved four per cent copper in the form of cuprus chloride: 250 grams per litre held 6.1 per cent. When employing hydrochloric acid for the same purpose, a 2.5 per cent acid solution held one per cent copper dissolved. A solution containing 250 grams sodium chloride per litre, and four per cent hydrochloric acid in addition, when cold held eleven per cent copper dissolved as cuprous chloride: when hot, 12.5 per cent. The working solution was heated to about 90° C. by passing exhaust steam from the engine into the sump tank, from which it was pumped to the leaching barrel.

* Compare Mines & Methods, Vol. II, page 212.

Heating the lixiviant had a beneficial effect, the action of cupric chloride on the calcined ore being much increased thereby. Calcined ore (12-mesh) when treated with hot cupric chloride gave an 83 per cent extraction in two hours: sixty mesh material gave 99 per cent in the same time. Without agitation, ninety per cent of the copper was extracted with a warm solution in two hours.

Only a small excess of cupric chloride over the theoretical amount required to dissolve the copper was necessary in the lixiviant. If after treating the pulp an excess of reagent remained in the lixivium, it was removed by means of cement copper, as described further down; or sulphur dioxide was passed into the solution, which reacted with the cupric chloride producing the cuprous salt, together with sulphuric and hydrochloric acids. The sulphuric acid thus formed reacted in turn upon the sodium chloride, forming hydrochloric acid, thereby compensating for the small amount of reagent lost in the wash-water. The sodium sulphate produced in these reactions did not interfere with the working of the process, either as to percentage of extraction, or as to time required to effect solution. The lixiviant used in treating a five per cent ore contained eleven per cent sodium sulphate. The maximum quantity of this salt which could be dissolved would be sixteen per cent in the cold, or thirteen per cent when hot, so that the lixiviant actually contained close to the maximum amount of sodium sulphate which could be held in solution.

The equipment for electrolyzing the lixivium comprised ten electrolytic vats, 7.5 feet long, forty inches wide, and eighteen inches deep—all inside measurements. These vats were constructed of pine wood, and put together without employing metal. They held water satisfactorily but warped badly when filled with lixiviant. Redwood was afterwards used to replace the pine, and it is

thought that the change would have overcome the difficulty had the work continued. Incidentally it might be remarked that redwood vats employed for leaching at another place quickly deteriorated under the action of acid chloride solutions.

Of the ten vats available only eight were used in the tests. These were placed in two rows of five vats each, with long sides parallel. Each pair (they had a slight inclination towards each other) was placed about six inches lower than the preceding pair, so that the electrolyte (entering at the outside ends of the first pair) flowed by gravity to the inside ends, and thence to the succeeding pair on the lower horizon. In this manner two currents of electrolyte were produced, each flowing through eight vats in succession.

The anodes and cathodes were arranged in the vats in sets of four pairs, there being five sets (twenty anodes with the corresponding cathodes) in each vat. These sets were placed in series electricly: in the eight vats there were forty sets. In the sets themselves the anodes and cathodes were connected up in parallel. The reason for this arrangement was that a forty-volt dynamo, driven by a 15 horse-power engine, had to be used, and it was desired to have a drop in potential of one volt to the set.

The anodes were electric-light carbons (fourteen inches by five-eighths) hung vertically from wooden frames. Electrical connection was made between the carbons by lead poured on the top piece of the frame in such a manner as to firmly join them all. The anode frames were suspended in canvas bags attached to the frames, which served as diaphragms. It was estimated that the cost of the bags would amount to about one-eighth cent per pound of copper produced: they lasted about three weeks. These canvas diaphragms were attacked at the surface of the electrolyte, and it was thought that covering them with asphaltum where they dipped into the solution might add to their longevity.

This species of diaphragm was found to have a high efficiency as regards diffusion in a cupro-cupric chloride solution. Only 0.75 per cent of the copper salts passed through such a diaphragm in 24 hours, showing an efficiency of about 99 per cent: with copper sulphate solution the diffusion amounted to one per cent in 24 hours.

The cathode sheets were also hung from wooden frames in the vats. There were two strips on the top of the frames which rested on the sides of the vats and through these the sheets could be slipped in and out. The sheets were made in the usual manner common in electrolytic refineries, and were about thirty-six inches wide. They were immersed from twelve inches to thirteen in the solution. The distance between anode and cathode was about 1.5 inches.

The current density employed varied from ten to twelve amperes per square foot. The deposited copper adhered to the cathodes and did not drop off. Nodules were disposed to form on them, however, and they were not coated heavily—about one-quarter inch. It was found practicable to precipitate the copper nearly completely in the cathode compartments—to about 0.2 per cent.

The solution in the anode bags was siphoned from one bag to the next, for, as already stated, the vats were placed on an incline, both as to their respective ends, and with relation to each other. This method of bringing about circulation of the anode liquors was defective, for as chlorine was given off at the anodes the siphons became filled with gas, stopping circulation completely. Changes were in progress to obviate this difficulty when operations were suspended. About one ton of copper was produced in all.

The final washings of the tailings from the leaching barrel were not subjected to electrolysis, but were passed over scrap-iron to precipitate the copper remaining in them. The cement copper thus produced was used to take up excess of cupric chloride in the lixivium coming from the leaching barrel.

It is to be regretted that these experiments were not carried to a point where commercial results were attained, conclusively showing the cost of producing electrolytic copper from non-ferrous copper silicate. It would appear that Mr. Herman had worked out a method of treating such material which contained elements of much promise; but experience has shown that no definite decision can be reached with regard to any new metallurgical process from laboratory experiments or operations on a small scale. Its value can only be determined when it is placed in commercial competition with established methods of ore-reduction.

PAST, PRESENT AND FUTURE OF COPPER

By HORACE J. STEVENS.*

The great copper industry of the present day is a thing of small beginnings. One century ago, in the year 1811, the world's production of copper was a trifle under 10,000 long tons, an amount smaller than was secured last year by any one of more than twenty different mines. During the present year the great Anaconda mine, of Butte, has produced, during nearly every month, as much copper as was supplied by all the mines of the world, in the entire year of 1811.

Fifty years ago, in 1861, the world's output of copper was but a trifle more than 100,000,000 pounds, a production that was exceeded, in 1910, by the Anaconda, American Smelters Securities Co., and Phelps, Dodge & Co. The production of the year 1900, the last of the Nineteenth Century, was just fifty times as great as that of the year 1800. Should the same ratio of increase be maintained during the twentieth century, the output of the year A. D. 2000 would be 24,318,150 long tons of copper, twenty-five times as much as the present production, and even a fifty-fold increase for the twentieth century would allow an average increase of less than four per cent, while the average annual increase, for the decade beginning 1900 and ending 1910, was almost exactly seven per cent, compounded yearly. Those who foresee a complete collapse in the copper industry would do well to give consideration to the actual figures of increase during the past. The copper industry does not move forward at even an approximately steady rate, from year to year, but is given to advancing by great leaps, almost inevitably followed by periods of quiescence, or even of actual retrogression. High prices for the metal stimulate production, while curtailing consumption, and as a direct consequence, output is increased, which decreases prices, which in turn brings about decreased production, due to the inability of small and weak producers to stand the strain of low prices. Decreased production again brings about high prices, and the cycle is begun anew. Much the same conditions existed in the American iron and steel industry for 50 years, until the formation of the United States Steel Corporation, which, while unable to prevent periods of depression, as its sponsors fondly hoped, has proven a wonderfully steadying factor in the iron and steel market, serving the purpose of a gigantic balance-wheel.

GROWTH OF COPPER INDUSTRY.

The growth of the copper industry

* An address delivered before the American Mining Congress, Chicago, October 25, 1911.

is best shown by the following figures of the world's production, by decades, in long tons: 91,000 tons in the decade ending 1810; 96,000 tons in 1820; 135,-000 tons in 1830; 218,000 tons in 1840; 291,000 tons in 1850; 507,000 tons in 1860; 900,000 tons in 1870; 1,189,000 tons in 1880; 2,373,000 tons in 1890; 3,708,000 tons in 1900; 7,390,000 tons in 1910. The influence of the electrical industry upon the consumption of copper is plainly shown by the figures since 1880. The production of the seventh decade of the Nineteenth Century was only 900,000 long tons, or a trifle less than ten times the output of the first decade of the century, while the production of the last decade of the century, ending 1900, was more than forty times the output of the first decade, and was more than four times as great as that of the decade ending in 1870, only thirty years before. The output of the decade ending 1910 was more than six times as great as the output of the decade ending 1880, and was almost exactly douole the production of the previous decade in 1900. The production of copper by the world, amounting to approximately 7,390,000 long tons, for the decade ending 1910, amounted to more than three-fourths of the total world's production of copper for the entire preceding century.

Figures of production and consumption of any given commodity in universal use may differ from year to year, according to whether a surplus is accumulated, or a preceding surplus is drawn upon, but over long-term periods, production and consumption necessarily are the same, and, figured by decades, it is safe to say that the figures of production are practically the figures of consumption. At present there is a copper surplus, of which much is heard, but to show how comparatively unimportant the present surplus is, when compared with the figures of output for the preceding decade, it may be stated that the world's surplus of copper, at the present time, is slightly less than 300,000,000 pounds of finished metal, or a trifle under 135,000 long tons, an amount less than 5½ per cent. of the total production of the decade, and equivalent to only about eight weeks supply of copper at the present time, measuring the supply either by productive capacity or by consumptive demand.

Very exact figures are available regarding production, dividends, costs and metal prices of the mines of the Lake Superior district since the first production was secured, in the year 1845, the total output for that year having been only 24,880 pounds of finished copper. The total production of fine copper, by Lake Superior mines, from 1845 to 1910, inclusive, a period of sixty-six years, or two-thirds of a century, was 5,122,478,402 pounds, having a gross value of $726,849,840, from which were paid dividends of $182,824,770, the ratio of dividends to gross values, for this entire period, amounting to 25.1 per cent., and dividends, divided by copper production, show average dividend payments of 3.56 cents per pound. The average price received for all Lake Superior copper, for this period of sixty-six years, was 14.19 cents per pound, which, after deduction of dividends, leaves an estimated cost of 10.63 cents per pound, for all years. By adding the figures of expenditures on unproductive mines, amounting to about $60,000,000, the cost of Lake Superior copper would be made almost 11½ cents per pound, and by adding a further $15,000,000 for assessments on mines that have since repaid in dividends the original assessments, the cost of copper would be made about 11.85 cents per pound, leaving a net margin of profit, for the entire production, of almost exactly two cents per pound, plus the present aggregate value of the various active mines.

Omitting the production of mines that have not proven profitable, the average cost of Lake Superior copper, yielded by dividend-paying mines, has averaged about 9.5 cents per pound, for all years, and the present cost of making copper, by all of the producing Lake Superior mines, probably is slightly above nine cents per pound. The actual average cost of making copper, in the leading producing fields, probably is between nine and ten cents per pound, at the present time. Some of the newer fields, which are skimming their cream, show lower costs, but it is difficult to see where the world will be able to produce its copper, in years to come, at an average cost materially under ten cents per pound, this figure excluding the limited production of badly planned and badly managed mines, which yield only a small fraction of the total copper output, but secure their metal at an average cost very much higher than the average cost of all mines.

For the immediate future, the supply of copper in sight is fully adequate, and no unduly high prices need be anticipated, but the figures clearly foreshadow another boom period, within the next two to four years, at which time the alarmists will be as badly scared, for fear that the copper supply is petering out, as they now are for fear that the production is so much greater than consumption that nothing but permanent disaster is in sight. Allowing an average increase of consumption of 7 per cent yearly, the figure that has ruled during the first nine years of the present century, the world's requirements of copper will amount to approximately 1,-650,000 long tons in 1920; 2,975,000 long tons in 1930, and 5,350,000 long tons in 1940—the latter named year, now only 29 years ahead, calling for a copper output almost six times that of the present rate. Twenty-nine years ago, or in the year 1882, the worlds production of copper was 181,622 tons, or about one-fifth of the present output. Allowing for even a five-fold expansion during the next three decades, to correspond with the five-fold expansion in the three decades past, the world's copper requirements in 1940 will be more than 4,500,000 long tons. Should the ratio of increased production and consumption remain at an average of seven per cent for the balance of this century, the world would yield and consume, in the year A. D. 2000, about 175,000,000 long tons of copper, a quantity of the red metal more than double the tonnage of the world's present production of iron and steel.

FIRST DECADE OF TWENTIETH CENTURY.

A survey of the progress made by the copper industry during the first decade of the twentieth century, now lacking only a few weeks of completion, shows no revolutionary changes, but does show steady and in some cases phenomenal progress, in nearly every division of the industry. In the matter of mines, the old districts of Butte and Lake Superior remain the largest producers, but Arizona, with a half dozen important copper fields, passed Montana in output in 1908, though again taking second place in 1909. In copper mining, the most important development of the decade has been the making of the so-called porphyry mines, in which disseminated copper sulphides are mined from schistose or porphyritic country rocks. The development of such important new producers as the Utah Copper, Nevada Consolidated, Miami and others of this class, has alarmed many people, who jump to the conclusion that the so-called porphyry mines must close down the older mines, developed on veins in Butte and other camps, and on the stratified trap beds of Lake Superior. There is no real occasion for this alarm, as the porphyry mines, while highly important, are not apt to be developed in large numbers. In fact, the entire western part of the United States has been scoured, by the keenest and strongest aggregation of capital in the copper business, for promising country-rock deposits, with a net result, to date, rather insignificant in the number of properties developed, though highly important in output secured al-

ready, and even more important in promise of future production. When the Mesaba iron range was opened, eighteen years ago, a similar wave of pessimism swept over the mine-owners of the older iron ranges in Michigan and Wisconsin, but time has proven that the high grade ores of the Mesaba, capable of being mined by steam-shovel, at wonderfully low costs, are absolutely necessary in furnishing an adequate supply of ore to the iron and steel works of this country, and similarly it will be found, as time passes, that the production of the porphyry mines is absolutely essential in supplying the copper needed by the world at anything like a fair figure to the consumer. Processes of actual ore extraction have been modified and imroved, in many fields, with a resultant increase in safety to miners, and decrease in cost of ore extraction. The steam-shovel has come to stay, in copper mining.

Strange to say, the copper mines which are vitally interested in extending the use of copper, were somewhat slow in adopting electric power but rapid progress has been made in this direction during the past decade and all of the mines of Butte are now electrified while there has been a great increase in the use of electricity in the Lake Superior district. The constantly increasing use of hydro-electric power is now restrained, and further restraints are threatened, by the conservationists. The newly adopted system at the Anaconda mine, in Butte, which combines the utilization of hydraulic, electric and pneumatic power, offers great possibilities of pliancy and economy, and the lead of the Anaconda is likely to be followed by many other important mines.

In ore reduction, material progress has been made in concentration, the very general adoption of Wilfley tables and similar devices permitting the saving of fines previously wasted. Hydraulic classifiers, settling tanks and a variety of ingenious devices for the saving of the uttermost mineral values, have aided in this work, and are now found in most important mills. Slimes, previously wasted, are now carefully collected in slum-ponds, and reworked; with an aggregate yearly extraction of many millions of pounds of copper formerly wasted.

Perhaps the most striking progress made during the past decade, in any division of the copper industry, has been in smelting. No new principles have been adopted in either reverberatory or blast-furnace work, but reverberatories of a gigantic size hitherto unknown have been adopted at many plants, while even more striking progress has been made in the capacity of blast-furnaces. Ten years ago, a 300-ton blast-furnace was considered exceptionally large, and near the possible maximum of size, but the Washoe works of the Anaconda Copper Mining Company, again blazing the way, now have two furnaces, each 56 inches by 51 feet in size, with a maximum daily smelting capacity of 1,800 tons each, and a third furnace that is 56 inches wide and 87 feet long at the tuyeres, this mammoth furnace actually having smelted 3,100 tons within 24 hours. It has been my privilege to see this great blast-furnace with smelting in progress at the western end, while the eastern end was frozen, and repairs in progress within the bosh.

The past decade has seen a further extension of the electrolytic process of refining, and the great bulk of the world's copper now is refined by electrolysis. In fact, very little finished copper, other than electrolytic, reaches the market, except from the Lake Superior mines, the product of which commands a premium by reason of its extra toughness and superior adaptability to drawing and stamping. With depth, many of the Lake Superior mines have shown a marked increase in arsenic, and for this reason a considerable part of the Lake Superior copper now is refined electrolytically, and sold as electrolytic and not as Lake copper.

COMBINES AND MERGERS.

At various times in the past efforts have been made at copper corners, but these have proven uniformly unsuccessful. The first copper corner was by the Associated Smelters, of Swansea, and might be termed the original copper trust. The Associated Smelters, which flourished from 1840 to 1860, were most arbitrary in their operations, buying cheaply, selling dearly, and zealously guarding their smelting processes. As a result of the very shortsighted policy of screwing prices of ore and matte to the lowest possible figures, while selling the finished product at the highest possible prices, with the ore producers aggravated by arbitrary charges for draftage and moisture, and the further grievance of unfair assay methods, the mine-owners were led to build independent smelters at and near the mines, in most of the principal copper producing districts, these effectually destroying the power of the Associated Smelters of Swansea as the arbiter of the copper industry.

The second attempt at a coper corner was made by the Societe des Metaux, of Paris, under the leadership of M. Secretan, the Societe des Metaux becoming in February, 1887, one of the sixteen underwriters that organized the Syndicat Secretan, with a nominal capitalization of $13,587,000. This syndicate contracted with the leading copper producers for their output, and speedily advanced the price of the metal to 17¾ cents, effecting an increase of more than 50 per cent in price within one month. Consumption immediately declined to a low figure, and the Secretan Syndicate borrowed enormous sums, to carry its rapidly accumulating copper, from French, German and English banking houses, the Comptoir d'Escompte of Paris alone lending the enormous sum of $33,368,000 to the Syndicat Secretan. This corner broke early in 1889, after about eighteen mnths' existence, and in a single day, in the spring of 1889, the price of cipper dropped from £70 down to £35 per long ton. About four years were required to clean up the wreckage remaining from this ill-advised corner, and put the copper industry soundly on its feet again.

The third attempt at a copper corner was made in February, 1889, by the organization of the Amalgamated Copper Co., which corporation maintained the price of copper, arbitrarily, at 17 cents per pound, until October, 1901, when an accumulation of 200,000,000 pounds of metal compelled a break that took the price of copper down to about 12 cents per pound, and about three years were required by the industry to recover from the effects of this corner.

The price of 26½ cents per pound, which was reached in March, 1907, by Lake copper, was not the result of any corner, but came about through an ill-advised scramble by consumers, who feared that they could not secure the metal. As a result of the high price, consumption was curtailed sharply, in all directions, as happens inevitably under such unsatisfactory price conditions, and the copper industry of the world still suffers from the existence of a surplus of slightly under 300,000,000 pounds of metal, remaining from a surplus that, including both visible and invisible supplies, reached about 450,000,000 pounds at the end of 1909, since which time there has been a small but steady decrease in surplus, from month to month.

The tendency in copper mining, as in all other branches of industry, is toward combination in ever-larger units. This tendency is based upon and governed by purely economic laws, and the laws of political economy are so much stronger than any law ever devised by a parliament, or any ukase ever promulgated by a despot, that it requires no spirit of prophecy to forecast the ultimate outcome of the present clash between the laws of political economy and the laws of congress.

In the copper industry the great bulk of production now is furnished by about

dozen dieffrent interests. The Amalgamated Copper Co. has a productive capacity of about 300,000,000 pounds yearly, with an actual output, last year, of 3,868,546 pounds. The American Smelting & Refining Co., or Guggenheim interests, have a productive capacity only slightly inferior to the Amalgamated, with an actual output of 174,150,000 pounds in 1910, which figure will be exceeded materially this year. The production of Phelps, Dodge & Co. was 116,-80,070 pounds in 1910, while smelter production, including custom ores treated, was 138,805,562 pounds, and the sales agency of this firm handled 194,138,696 pounds of copper last year. The Calumet & Hecla, with its subsidiaries, has a productive capacity of nearly or quite 150,-000,000 pounds yearly. The Rothschild interests, controlling the Rio Tinto of Spain, and the Boleo of Mexico, have a copper output of more than 100,000,000 pounds yearly.

The leading copper producers of the world are now operating under check, a 16 per cent reduction in output having been put into effect in August of last year. Under the Sherman Anti-Trust law, this checking of production would be considered criminal, if it could be proven, yet the reduction of output was absolutely necessary in order to save the copper industry from a prolonged period of utter demoralization, during which scores of millions of dollars would have been lost by investors, and a quarter million or more of working men would have suffered severely, many of them losing their jobs, and the remainder suffering severe cuts in wages. We have the authority of Eminent Statesmen, totally devoid of business experience, that the Sherman Act is a panacea for all ills of the body politic, yet no sensible business man would do otherwise, if he had the power, than to reduce production, at a time when a surplus product threatened not only the small remaining profits, but the very foundations of the copper industry. The issue thus is drawn very plainly between our present politico-criminal law, and all the laws of business and of political economy.

BUSINESS AND POLITICS.

I have no connection, direct or indirect, with any copper mining company or copper producer, except that, in a general way, I have small business dealings with a great majority of the actual copper producers of this and foreign countries, hence I speak without personal prejudice, and not as the mouthpiece of any individual copper interest.

The greatest present menace to the copper industry in the United States is a menace that is common to all branches of mining. The entire American industry of mining is threatened by men operating under the names of progress and reform, whose slogan is conservation, but who are political economists of the Stone Age, and first cousins, in mental capacity, to the Troglodytes. The conservation experts of the forest service are systematically hampering legitimate mining operations throughout the western states, and both law and justice are disregarded by these conservationists, while the federal departments affected are governed more by rulings than by law. Congress has made the very grave and dangerous mistake of endowing the executive departments of our government with the power to promulgate rulings that have the force of law, and in some of the departments rulings have been put into effect that not only are arbitrary and unjust, but that also are absolutely illegal, yet the poor miner, who has complied with all the requirements of the law, is liable to see his property, to which he is clearly entitled, both by law and justice, taken from him by the officials of the forestry service, under the slightest pretext, and is denied access to or recourse by the courts. The most odious forms of despotism can show nothing worse, in this particular, than the hideous imposition under which honest miners are suffering in the western states of our country.

ANACONDA AND GUGGENHEIMS.

The conservationists, many of whom might, with greater truth, be termed conversationists, would close the Washoe Works of Montana, the greatest reduction plant in the world, with a monthly output valued at millions of dollars, employing thousands of men, and indirectly giving employment to tens of thousands of men, under the childish plea that the smelter fumes are injuring timber on the federal forest reserves—timber that, in a pinch, might furnish fairly good lodge-poles for Indian tepees.

The Guggenheims are the bogey-men with which the conservationists most frequently alarm the public. We have had it dinned into our ears, by innumerable patriots seeking office, and repeatedly set before our eyes, in every yellow newspaper and muckraking magazine, that "the Guggenheims are stealing Alaska." As a matter of fact, the Guggenheims control a copper mine in the interior of Alaska, that is a wonder in its way, yet which cannot be rated at more than a third-class property. Th's mine, the Bonanza, is a sort of copper-plated gold-brick, in that an interior core of limestone is surrounded by phenomenally high grade bornite and copper glance. No competent mining man who has visited this property ever has estimated the amount of ore in sight, and safely to be inferred, as capable of yielding more than 100,000,000 pounds of finished copper, a total production equivalent to only one year's maximum output by any one of the six leading copper mines of the world.

In order to get this ore out of a wilderness, the Guggenheim interests have built the Copper River & Northwestern railway, a line of 195 miles length, variously estimated to have cost from $13,-000,000 to $25,000,000. The gross value of all the copper contained in the Bonanza mine, taking the outside estimate of tonnage, is considerably less than the lowest estimate of cost of this railway, and the net profits derivable from the Bonanza mine, cannot, by the most liberal figuring, be estimated at more than $4,000,000 to $5,000,000. Instead of being commended for their enterprise and courage in building this railway through an arctic wilderness, the Guggenheims are held up to public scorn as thieves and robbers. This railway cuts through workable beds of coal, but is prohibited, by the federal authorities, from developing or using this coal, and is compelled to import inferior coal, from British Columbia, at a cost more than double that of domestic coal, if its mining were permitted. Not only does the railway suffer from this arbitrary action by the federal government, but the 50,000 unfortunate American citizens who live in Alaska are compelled to pay double or triple the price they should pay for fuel, through the efforts of the conservationists, backed by the federal government, to 'save" the coal for some future use, at an indefinite date. It scarcely seems strange, in the light of this situation, that mourning was donned in Alaska when the High Priest of conservation reached that land, which the conservationists seem to consider a sort of penal colony. The conservation of our mineral, timber and power resources should be effected along legal and business lines, and not under the guidance of spiritualistic visions.

The reformers, as these gentlemen term themselves, are advocating the government building and operation of railways in Alaska, and the government ownership and operation of coal mines, which is state socialism pure and simple, and any man seriously advocating such a policy is a socialist, no matter what he may choose to call himself. It is further advocated by the junior senator from Wisconsin, and his official and unofficial organs, that the government also should buy the Copper River & Northwestern railway from the Guggenheims. Doubtless the Guggenheims will be very glad indeed to sell their railway, which is threatened by tidal floods and glacial floods, with its principal bridge across the Copper River threatened by a gla-

cier itself, but it is difficult to see where the long-suffering taxpayer will benefit by such a purchase.

GOVERNMENT POLICIES DENOUNCED.

The federal government already has withrdrawn immense tracts of oil, coal and phosphate lands, and the next step in this cleverly devised socialistic propaganda will be to withdraw from entry, or inhibit mineral entries upon iron, copper, lead, zinc, silver and gold lands.

The pretext for past withdrawals is that our mineral resources are being depleted so rapidly that there is danger of their extinction, in the near future, unless administered by an all-wise and all-powerful central government, which can make no mistake, and can do no wrong. The figures regarding our natural resources, put forth apparently in earnest, by some of the leading conservationists are so utterly ridiculous that it is impossible to regard them seriously. There is more iron ore existing in a single county, in my own state of Michigan, than any professional conservationist ever has estimated to exist in the entire world. This is made as a plain statement of fact, and those who think to the contrary are challenged to impeach the assertion.

The lawless actions of the forestry bureau, which is perhaps the most odious of our bureaucratic iniquities, have been of a sort to arouse the alarm of all thinking men who believe in self-government. Apparently it is the cunningly devised scheme of the leaders of the so-called conservation movement, to appropriate the public lands, now held by the federal government in trust for the benefit of any and all citizens who will develop them, and hold these public lands for the sole benefit of the bureaucrats, who will enjoy the usufruct, through a carefully planned system of leases, by which the water-power, forests, mines and arable lands will be leased to corporations that are amenable to the benevolent control of the doctrinairies, and to individuals who can be terrorized to conform to the exactions of the bureaucracy. The opportunities for graft that are contained in such a system are almost inconceivably great, and comparing their claims with their actions, the conclusion is irresistible that the conservation movement, as now managed, is not a genuine effort to improve the condition of the American people, but a cleverly devised scheme to deprive the people of their landed heritage, and fix upon their necks the iron collars of serfdom, to the end that a more gorgeous and richly endowed bureaucracy may flourish upon the soil of what once was a free country.

It is said, and apparently with reason, that the spy system of the United States is now the finest and most extensive in the world, excelling even those of Russia and Turkey, heretofore the most progressive nations, in the matter of thoroughly organized espionage. We also have the benevolent activities of an attorney-general who is now vigorously prosecuting the kindling-wood trust. It is obvious that the shaving-paper combine and the office-towel monopoly had better watch out, for their turn may come next. Why does not the attorney-general prosecute the labor unions, which are trusts in the meaning of the Interstate Commerce law, existing in open defiance of the beneficent provisons of the Sherman act. The answer seems obvious. The present activities of the United States Department of Justice, as it is termed, officially, afford a spectacle for gods and men.

Business throughout the United States is suffering from uncertainty—which has been accentuated, rather than decreased, by the recent decisons of the Supreem Court, which read into the Sherman act a provision that only "unreasonable" restraint of trade should be punishable, under the terms of this act. As Richard Olney justly remarked, this leaves the Sherman law about as clear as if congress were to pass a law stating that only a 'reasonable" tariff should be imposed, and leave the adjustment of all duties to the Supreme Court of the United States.

This nation has been made great and prosperous by the initiative and enterprize of the individual, yet the theorists bid us throw aside the habits and course of conduct of centuries, and depend solely upon the initiative—God save the mark—of the bureaucrats. Why not speak out boldly, what all sensible and patriotic citizens are thinking, throughout this country? We are suffering from a most odious form of bureaucracy, fortified by an extensive system of paid spies, an organized claque, a clever press bureau, and the systematic support of that section of the press noted mainly for its dubious motives and devious politics. Some citizens with defective hearing take the clamor of this portion of the press, desirous of cheaper wood pulp, for the real voice of the nation. It is time that the yellow newspapers, muckraking magazines and purely political conservationists were told to stand aside, and permit the federal government to be run, once more, in accordance with law and common-sense. Some of the gentlemen who are preaching progress and conservation, have combined moral platitudes with business turpitude, and label their product as reform. In the name of progress they bid us turn our faces to the rear; in the name of conservation of our natural resources, for generations yet unborn, they forbid us to utilize the mineral, power and timber resources required for the needs of the present generation. Their plan of state ownership of mines and water powers is state socialism, very thinly disguised. These men are enemies of the republic, who, under the specious cloak of declamatory patriotism, would rob us of our right to self-government.

Our worthy president takes the stand that because the Sherman act is law, it must be enforced rigidly, regardless of consequences. If this be the case, it necessarily follows that all federal laws must be rigidly enforced, regardless of consequences, and it would be interesting to learn why our federal government does not enforce, or even attemtp to enforce, the fifteenth amendment to the Constitution of the United States, which reads as follows: "The right of citizens of the United States to vote shall not be denied or abridged by the United States, or by any state, on account of race, color or previous condition of servitude." Is it possible that the Sherman Act takes precedence of the Constitution?

DRESSING A CEMENT FLOOR

Many power users who have installed engines on large concrete foundations leave the surface of the concrete just in its comparatively rough condition as a floor for the engine-room. This is a bad practice, as the sand in the concrete is apt to come away with constant walking on it, and a large percentage of it eventually finds its way into the engine bearings, with results far from beneficial for the engine.

Wash the floor thoroughly with clean water, scrubbing with a stiff broom or scrubbing brush to remove all dirt and loose particles. As soon as the surface is dry, apply a solution of one part of water glass or sodium silicate, and three to four parts of water, the quantity of water depending on the porosity of the concrete. The denser the concrete the weaker will be the solution required, as it is necessary to penetrate the pores of the concrete. Do not mix more than can be used in an hour, and apply it with a large whitewash brush. After the first coat is dry, mop the floor with clean water, allow it to dry, and apply a second coat. Mop and dry again, and apply a third coat, and if the surface is not too good a fourth coat also after the same procedure. After it has dried thoroughly and received another mopping the result will be an extremely hard, dustless surface.

UTOPIAN ORE DRESSING METHODS

ONE OF THE UTAH COPPER COMPANY'S MILLS GOING TO THE SCRAP-HEAP

[REPRODUCED FROM JULY, 1910, ISSUE.]

As promised in our last issue we undertake to review as briefly as possible the extraordinary and chequered experience of the managerial department of the Utah Copper Company in its futile and costly efforts to install a successful system of ore dressing, without having first learned at least something of the rudiments of established practice, or sought the advice and aid of those who were familiar therewith. We do not in the least disparage the ability of the manager, or his mill superintendent, Mr. Janney, when we say that at the commencement of their employment by the Utah Copper Company, neither possessed any knowledge of the principles involved in ore concentration, or had ever had the slightest practical experience in work connected therewith. It is true, however, that Mr. Janney had for a short time run an engine which drove the machinery of a small concentrating mill, but as before indicated, had never been engaged in practical work or ore crushing or concentration, whereas Manager Jackling's experience had never extended outside of the field of smelting or chemical treatment of ores, but each was regarded as capable and efficient in his respective field of occupation.

It had been the good fortune of Mr. Jackling, as indicated in our last issue, by reason of his employment by Captain J. R. DeLamar at the Golden Gate mill at Mercur, to become familiar with the result of exhaustive examinations and working tests made of the mines and upon the ores of the Utah Copper properties by Victor M. Clement, Duncan MacVichie and other engineers employed by DeLamar, pending an option which he held to purchase certain interests in the property, and being of a thrifty turn of mind, he was able when the opportunity arrived, to use this information to very great personal advantage, as we also showed in our last issue.

It also appears that he had made use of this knowledge, but without substantial results, upon a former occasion, as will be seen from an excerpt from a report or letter written by him and addressed to Major R. G. Edwards Leckie, then temporarily located at Republic, state of Washington, as manager of a property where Mr. Jackling was employed in operating a "cyanide" plant. After a somewhat detailed description of the property in which he stated that there was at that time, March 20, 1901, reasonably called developed ore exceeding in amount "twelve million tons," the report proceeds as follows:

"During the summer of 1889 I undertook some metallurgical experiments on this ore, and concentrated several hundred tons taken from the tunnels and dumps at random. The mill which I used was an abandoned 5-stamp mill, without any particular adaptation to the ore, and without appliances for making a close saving. By crushing with light stamps to 25 to 30 mesh and concentrating roughly over a Wilfley table without sizers of any kind, and without special endeavor to save values from the large amount of slimes produced, I made a saving of 71.7 per cent. Some experiments made in a rough way by collecting slimes and running them over a vanner, resulted in an additional saving of about 15 per cent, or a total of 90 per cent of the copper values, but I have made my estimates on a basis of 75 per cent saving. The ore is an ideal one for concentration, the grains of chalcopyrite breaking perfectly clear and free from the porphyry gangue, and readily yielding a concentrate carrying 25 per cent copper."

In a letter transmitting a copy of the "report" referred to, and dated Republic, Wash., April 4th, 1901, Mr. Jackling said:

"I want to assist you in every means possible in this matter, both for the reason that I would like to make some money out of it, and that I would like to see the deal go through and people get hold of the property who can and will do something with it. I do not know of a property on earth I would be more pleased to equip metallurgically myself than this one, and if the thing can be swung, I have hopes in that direction. * * * In consequence of my work on the Bingham experiments, I am able to give pretty accurately almost any information desired about the metallurgical end of the business."

The milling tests here referred to by Mr. Jackling were, for the first few days, conducted by a Mr. Forrester, who was very expert and reliable in that class of work, but who was superceded by Mr. Henry M. Crowther, also a man of ability, Mr. Jackling of course not being present and having no part in the work except that of assisting in metallurgical determination of the values contained in the samples taken for assay, which were sent to Mercur and treated in the mill laboratory at that place under his supervision. It is evident that the result of the figures, 71.7 per cent, given as the proportion of the copper contents recovered in the operation of the Wilfley table and the additional 15 per cent said to have been recovered from the slimes on the vanner, were carelessly or hurriedly copied from the reports of Forrester and Crowther, because 71.7 per cent and 15 per cent do not make quite 90 per cent, the total recovery claimed to have been secured.

It is quite evident that President MacNeill and associates never for a moment doubted that the DeLamar tests were actually made by Mr. Jackling, which fact in part no doubt accounts for the many blunders into which the manager drifted in attempting to conceal the facts and his lack of knowledge of the business in hand.

The employment of a capable man to take charge of the ore dressing department would have resulted in the exposure of the total ignorance of the subject of both the manager and his assistant, Mr. Janney, and besides would have spoiled the "record" that each hoped to make. True, the manager thought Superintendent Janney knew how, and would not claim all of the credit, whilst the superintendent evidently thought he could pick up the necessary information as the work progressed to enable him to conceal his lack of primary knowledge from the manager.

Results prove that both were right for a time in respect to their estimation of each other, but, as time and events progressed, the failure of each fool scheme began to tread so closely upon the heels of the next, that a collapse often seemed inevitable. But luck was with them, for the exigencies of the share market at all times rendered a change of management extremely hazardous, and hence the hired press continued to subordinate the importance of the millions that were daily added in value of ores, to the matchless engineering skill of the manager and then, at the psychological moment, the wonderful properties of the "Garfield table" were discovered, which for the time being seemed to have averted the impending wreck of the entire Utopian fabric. Even the advent of this messenger

would doubtless have failed to stem the exposures of Mines and Methods except for the timely change of the name of the "Garfield mill" to the less euphonious one of "Magna plant." At the same time, in order to prepare the Boston mill for intestinal regeneration, its dignified cognomen was discarded for the more aesthetic "Arthur plant." But the "Copperton plant," which had been the embryo of so many brilliant conceptions of misguided genius, seems to have been overlooked in the process of rechristening.

COPPERTON PLANT TO SCRAP HEAP.

This was a fatal oversight, and as a consequence orders have been received from the head office, commanding that it be closed down permanently, and offered for sale, either as a whole, or in units or segments, to suit any purchaser. This was to have been expected after the analysis of Manager Jackling's annual report published in Mines and Methods, which shows that the actual cost of all copper produced at that plant for the year 1909 was fourteen cents a pound, and for the year 1908, 10½ cents, and this exclusive of its share of the costs of stripping the ore treated, which would have added about 1½ cents additional to the cost per pound of copper produced.

Just what explanation will be offered to stockholders and the public for this action it would be difficult to conceive, because it has been persistently stated that the new Garfield plant is an exact duplicate of the Copperton. It is operated by power generated at the Garfield plant, so that it could not be a question of excessive cost in driving power. Its capacity was 1,000 tons a day, which should render its operation in all respects quite as economical as that of any two of the 500-ton units of the Garfield plant; besides, there is an advantage of 15 cents a ton in the freight charge on ore delivered at Copperton as compared to the rate paid on ore delivered at Garfield, the former rate being 12½ cents, and the latter 27½ cents per ton, the difference being equal to a little more than three-quarters of a cent per pound of copper produced.

Moreover, the burden of the cry of the management and its hired press had been for INCREASED MILLING CAPACITY, and we are told daily that most strenuous efforts are being put forth to increase the consuming power of both the Garfield-Magna and the Boston-Arthur plants to the extent that twenty thousand tons daily shall be drawn from the limitless cuprous fields of the Bingham monzonites. Why then should this Copperton mill, "the mother of inventions," at the very zenith of success, and after having so long and well performed the dual functions of matron and wet nurse to the brood of new-born ideas which we are told are destined to revolutionize the copper industry, be consigned to the merciless auctioneer, or the scrap heap?

To those who have followed the exposures of this journal, the answer is not difficult. The public have refused to be fooled by the false cry of cheap copper production and have refused to buy their shares, and as a result the pooled interests have become loaded to the breaking point, and now to escape further drain upon their weakened resources in pretense of doing their share in curtailing production, they have gladly decided to close this unprofitable plant. But, whatever has been the cost of production at the Copperton plant applies with even greater force to the Garfield, and were it not for the disaster that impends holders of the pooled stock, this plant would undoubtedly be closed also.

HOW FAILURES COME.

Unfortunately it is a fact that although theoretical and to some extent practical ore dressing forms a part of the mining engineer's college course, only in very rare instances does the graduate pursue these initial lessons into the field of actual practice, and this solely for the reason that the operation of an ore concentrating mill does not comport with the professional dignity of the average mining engineer. Hence the operation of these important appendages is usually assigned to some dependent relative or friend who has a "pull" with the manager, and who in turn, if he be wise, selects his foreman and crew from those who have had practical experience in the different departments of the work, and so has the successful practice of today been handed down from the generations which sprung from the old Cornish and German ore-washers of the past, so that if you want information of real practical value as to the best method of treating a particular ore, you go to the man who is successfully treating a similar ore. If you want to know WHY a Wilfley table, or other device is most efficient in the recovery of the valuable mineral, ask Wilfley, or the inventor of the machine in question, but if you want to KNOW HOW TO OPERATE the machine in order to secure the best results, ask the man who OPERATES this most important unit in the plant.

These observations are simply designed to impress upon the engineer the importance of a liberal PRACTICAL APPLICATION of University theoretical studies, in order that there may be combined in one head sufficient actual knowledge of the subject to enable the possessor to design and manage the erection of a complete structure which shall combine all the elements employed in the successfully operated plants in use for treatment of ores of the kind to which it is to be applied, for no engineer is justified in squandering other people's money in attempts to reinstate obsolete and useless devices; nor is it in the least disparaging to the ability of the most intelligent engineer should he find it necessary to seek information and aid in his work from men occupying inferior positions, because, as before indicated, the actual practice of ore dressing is little understood by the average engineer or mine operator. On the contrary, his thoughts and ambitions run rather to the promotion of mining deals in which a liberal rake-off may be secured, as a premium or reward for his skill in manipulating his friends and the general public, without regard to merit of property, or the process by which ultimate values are to be recovered; and so it frequently happens that highly remunerative pecuniary results follow the flotation of wholly worthless properties, and likewise mining properties of great value are frequently destroyed by grasping or dishonest methods of incompetent, self-styled mining engineers.

Coming now to the subject of this article, the mines now controlled by the Utah Copper Company were at the date of their acquisition little known outside of the former owner and a select few, who, as before indicated, by reason of their employment had access to the reports of the engineers employed by Captain DeLamar in exploiting the property under an option to purchase an interest.

As before stated, it is quite evident hwever, from the unlimited responsibility placed in the hands of Manager Jackling by President MacNeill and associates, that they had accepted his second-hand reports as demonstrations of actual knowledge, or possibly, perpetual management of the property with its millions to spend was awarded to him as his share of profits in the deal whereby the Guggenheims secured the contract to smelt all the concentrates to be produced at double the current rate, and MacNeill and associates in return secured twenty dollars a share for a large portion of their original holdings, the first cost of which was only about fifteen cents a share, as was shown in the June issue of this magazine.

WHEN BLUNDERING BEGAN.

The Copperton mill was erected by a local corporation, called the Utah Copper Company, which preceeded the present company, and held the option to purchase a controlling interest in the mining prop-

erty at a stated price in cash, and in addition required the erection of a first-class concentrating mill having the capacity to treat successfully 500 tons of ore per day, the cost of which it was understood would be at least $250,000, which was to be borne by the proposed purchasers. Mr. Jackling was made manager of the company and Mr. Frank G. Janney was employed as chief engineer of construction.

In learning that it was the purpose of the manager to employ in the fine crushing department an old grinding device called the "Chile" mill, the owner of the property entered a vigorous protest, urging the adoption of the method in universal use for similar work, which was rolls, to be followed, if necessary, by Huntington mills, also in general use. But it was urged that, owing to the extremely soft and friable character of the ore, complete results could be had with rolls alone. It was also pointed out that exhaustive competitive tests had been made at the Washoe plant at Anaconda, Montana, with Chile mills, rolls and other fine crushing devices and that as a result the Chile mills had been discarded as absolutely destructive to successful concentration.

Finding the manager unmovable in his purpose to adopt the Chile mill, the owner of the property, in order to avert the failure which he thought would result from their use, offered to waive the requirement of the option and accept instead an experimental plant of only twenty-five tons capacity a day, or to build a complete modern plant of 500 tons capacity and guarantee results equal to any mill in use treating ores of like character for $75,000, but both proposals were refused. The former, no doubt, because a market could not be made for shares upon the operation of a mill of such diminutive proportions, and the latter because the manager and his assistant could not make a "record" in the operation of a mill which they did not design, not to mention possible royalties on a patented feature

And so the mill was constructed upon their own design, but chiefly of second-hand machinery brought from Colorado. Three of the Chile mills, however, were the identical mills which had been discarded as the result of the test referred to at the Washoe plant. Another, and new mill, carried a supposed valuable improvement which was the subject of a patented invention devised and owned by Superintendent Janney, which it is said, is attached to all the Chile mills which subsequently were installed in the Garfield plant.

In due time the mill was completed and put in motion, but results from the start were most discouraging. It was found that whilst the grinding capacity of the Chile mill was very great, the valuable mineral contained in the resulting pulp had been ground into an impalpable flour which resisted every device designed for its recovery.

The fault was at first attributed to the hydraulic classifiers, which refused to classify, and so an assault was made upon those helpless things, but without beneficial results. The superintendent became quite tame and appealed to visitors for information as to the usual habit of this now interesting device, but for many days no one appeared who seemed able or willing to explain the cause of its rebellious conduct.

GOOD ADVICE IGNORED.

The manager seemed disinclined to encroach upon the prerogative of the superintendent and discretly offered no advice. Finally a visitor appeared who had seen something similar in appearance before, and soon discovered that instead of the usual spiggot used for discharge of the classified product being placed directly beneath the several compartments of the classifier, a two-inch nipple had been inserted, and a T with some 2½ feet of pipe attached with extended out horizontally, at the end of which the discharge of pulp was provided by means of a valve, the classifying water being introduced through the vertical portion of the T. Of course if the valve was closed sufficiently to admit only the desired amount of pulp the long horizontal stem of the T would fill up with mineral, and if opened sufficient to force the pulp through the valve, there was a rush of water, but no classification.

Simple instructions were offered how to cure the trouble, but the superintendent was not satisfied, and so he struggled on until he secured a copy of Richards' work on ore dressing, where he found satisfactory relief, but the losses due to overgrinding continued and still continue to the extent of 14 to 20 pounds of copper to each ton of ore treated. Another, and equally serious trouble appeared in provision which had been made in the trommel screens which were designed to separate finished product after it had passed through the rolls. It was found that after passing the coarse breaker and the rolls that 35 to 40 per cent of the pulp was crushed to the proper degree of fineness—about 30 mesh —and that this portion of the crush yielded excellent results upon the concentrators. In order to eliminate this portion before sending the oversize to the Chile mills, two revolving trommels were provided, one discharging into the other. The head trommel was covered with wire cloth of about 5 mesh, or 3½ millimeter openings, the other was covered with 30x30 brass wire cloth. The oversize of the head screen was returned to the rolls and that of the other screen went to the Chile mills. Of course the result of the excessive quantity of coarse material being passed over the fine screen, was the destruction of its delicate and costly fabric in about thirty-six hours.

The matter of excessive cost did not disturb the manager, but the loss of time and labor in making the necessary renewals was most exasperating. Results during the short life of the screen cloth were, of course, quite satisfactory, but the cost of renewal of screen cloth was not less than thirty dollars a day for each of five trommels, and so the work went merrily on for several months, until it was said the bill for screens for trommels alone aggregated some $75,000.

At the outset of the struggle the same person who had volunteered a remedy for the cure of the classifiers suggested that all that was required to insure satisfactory duration of life to this finer screen was the introduction of two other screens of intermediate mesh openings between the fine and coarse screens then in use, which would skim out the coarser material and allow only such sizes of material to enter the fine trommel as would approximate the size of the screen openings; that with such arrangement the fine screen would stand the wear of its proportion of the pulp as well, and would last as long as the coarser fabric, but as that part of the mill structure had been so designed as to accommodate only two trommels—end to end—it was suggested that a very common and effective practice in such cases was to lengthen the screen arms sufficient to admit of placing two more screens of proper intermediate size, opening on the coarse trommel outside of the original screen.

But this was not adopted, probably because the superintendent did not know how to first think of it himself, but in course of time he evolved a scheme of his own, and thus saved his "record." He had seen jigs used, and knew they were equipped with screens, and that by covering a coarse wire cloth in a jig with a quantity of mineral coarser than the cloth mesh, only the finely crushed portions of the pulp to be treated would pass through the screen and so trial was made first with two or three jigs of the Hartz plunger type, the screens being bedded with lead shot, and, sure enough, the greater portion of the coarser "fines," ore and sand passed through all

right, whilst the finer particles of mineral and uncrushed rock passed over the tail and was returned to the Chile mill to be ground into flour, which was just what they seemed to want.

From this on the number and kind of jigs installed increased with commendable rapidity. Even the Hancock jig was tried, but proved unsatisfactory, then Woodberry seemed to take first place, with the result that the trommel scheme of screening out the finer material was abandoned. The hutch product was not perceptibly enriched by the process, but afforded, when classified, a good feed for the Wilfley table. The result of this brilliant scheme was heralded by the hired press as the most wonderful advance in ore dressing of the century. Its operation, as against the ordinary and simple method of screening, involved an excessive cost equal to more than a cent a pound upon all the copper produced during the years of its use both at the Copperton and Garfield mills, in addition to the increased waste due to the greater quantity of material that was sent to the Chile mills, the sum of which loss of otherwise recoverable mineral is equal to more than three cents per pound upon all copper produced at both mills.

We have shown in former issues of this paper that the average recovery of the mineral contents of the ore treated at these mills never exceeded 63%, and the average for an entire quarter has been less than 48%. That 55% is a liberal allowance for the average recovery, as compared to about 72% recovered at the Nevada Consolidated and the Boston Consolidated mills, and that this great disparity is due solely to the destructive effect of crushing, or rather grinding, with the Chile mills. It is evident that our comments and criticism has brought about the desired reformation, as a few months ago a system of finer screening was quietly installed at the Garfield plant, whereby all material larger than about one milimeter and smaller than about four milimeters, which had previously been sent to the Chile mills, is nnw returned to the rolls, thus reducing the grinding heretofore done by the Chile mills by about 65 or 70 per cent.

Of course, improvement in recovery of values, and increased capacity of the concentrators, was startling, but strenuous efforts were put forth to conceal the real cause of the improvement. President MacNeill announced that it was brought about by screening and then "crushing dry" with rolls, which he sought to make the public believe was the result of an entirely new discovery in ore crushing, as if ores were ever crushed in any other way with rolls than dry where the conditions admit of such crushing—or that water is ever introduced except in crushing clayey ore.

And then this discovery was followed by the still more startling discovery of the Garfield table, which he says (in the Boston News Bureau) has superceded all of the hundred or more jigs. This is certainly an important advance, because jigs never had any excuse for their presence in the economy of ore dressing where 65% of all the material to be treated could pass double file through the openings of a 200x200-mesh screen.

WALL'S RIFFLE IDEA ADOPTED.

Now, as to this very remarkable table. It is simply in every effective principle a Wilfley table, and its use no doubt would be restrained except for the fact that the Wilfley riffle patent has probably expired. The riffle is patterned after a riffle which has been in use on a patented table in Wall's mill at Bingham for three years past. It is rectangular in form, about one inch thick at the head end and tapers about ¼ inch at the tail, and extends the entire length of the table, which, like the Wall table, is set so that the tail is higher than the head by the amount of bevel, longitudinally, in the the riffle. When in operation the surface of the riffle is level from head to tail. It has the capacity of probably four Wilfley tables. It is fed with material from the finest sizes to 1 or 1½ milimeters. The effect upon the pulp is to discharge over the side all of the coarser sands, together with much of the extreme fines—as in the Wilfley—which is returned to the Chile mill for further crushing—whilst the intermediate grade sands and mineral which adheres to the table is carried forward and discharged over the end, whence it is elevated to classifiers and dressed on Wilfley tables. The product is slightly enriched by the process, but no finished product or rejection of tails results from the operation, so that the mixed product must still be subjected to the same process and labor of rehandling as would the original pulp if delivered to the regular tables properly classified.

Whatever dimunition in quantity has resulted from the operation of the Garfield table, due to the elimination of the slimes and oversized material is balanced by the transfer of the same material to another department of the mill for treatment after it has been passed through the Chile mills and thereby rendered more refractory than ever. If only a small portion of the worthless sands were rejected in the operation it might be made to appear that something had been gained, but to slough off and send to the grinding mills sands which are already crushed sufficiently to liberate any recoverable mineral and thus increase the difficult task of dressing other portions unavoidably slimed, is too absurd for serious consideration. And when the fact is taken into consideration that all this floundering is the result of efforts to cover up the inexcusable blunder of refusing to adopt a sensible method of screening out the finished product at the outset, this latest novelty becomes a silly joke.

If now the screening system be extended one more short step, and all oversize material be returned to FINISHING ROLLS, the entire system will be as complete as the ill-arranged plan of the plant will permit. This would put the Chile mills in the scrap heap, of course, but the stockholders would enjoy the luxury of an honestly earned dividend which, up to this time, they have never received, and they will then know that the difference in the value of what might have been and what has been recovered amounts to not less than four millions of dollars, the equivalent of which now slumbers in the tailings pond.

We shall now shortly be advised by the hired press that the Utah Copper Company has performed its share of duty to the metal interests by temporarily closing the Copperton plant, but it can hardly be expected that stockholders will be informed that Superintendent Janney has already conducted prospective purchasers of junk through the plant and informed them officially that it is for sale as a whole or in parts. Such admissions would hardly be consistent with President MacNeill's recent statement that the plants were all new and still growing, and therefore it was not yet time to charge off anything on depreciation account.

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According to advises from Guatemala, the government of that country has recently granted to an American company the exclusive right to exploit all mines discovered on the public lands of Guatemala in return for a tax of ten per cent of the net profits of the company, which is to be organized in the United States with a minimum capital of $10,000,000 American currency. It is understood that Senator W. A. Clark and former Governor A. E. Spriggs are backing this new organization. French capital is also said to be interested in the deal. If consumated, the new company will begin active operations at once and with this large amount of capital at the company's disposal for exploration and exploitation purposes a great development of the mineral resources of Guatemala is to be expected.

MERITS OF SO-CALLED SCREENLESS SIZING

The exploitation of the merits of the recently patented "McKesson Screenless Sizer," which has been described in several mining and metallurgical journals during the past few months, is bearing fruit in the way of criticism and comment that is sure to prove educational and instructive to all interested in the best methods of extracting values from ores of various kinds. Carl F. Dietz and Dyke V. Keedy, consulting and metallurgical engineers of Boston, who, through their intimate identification with a process of their own for the classifying of complex ores, are qualified to speak, are credited with the following lively discussion—on the merits of the newest machine—in Metallurgical and Chemical Engineering for this month:

SIZING WITH OR WITHOUT SCREENS

The greater interest taken in recent years in the possibilities of the dry concentration of ores has brought out, aside from marked improvements in magnetic and electrostatic processes, several new and ingenious forms of dry concentrators, or rather tables, which have successfully overcome the difficulties of the early attempts at dry concentration. The prejudices against dry concentration in general, which in some instances may be justified by the many failures of the past, are most generally the result of ignorance or a disregard of the fundamental principles involved.

It is not the purpose of this paper to discuss the relative merits of dry vs. wet concentration. It may, however, be mentioned that each has its own field. Only a careful study of the mixture to be separated, together with local conditions, can determine which system is the more desirable. Such decision should, of course, in every case be verified by the treatment of a representative quantity of the material. While it is evident that close and accurate sizing as a requisite to successful dry separation, especially in the case of a complex mixture showing close specific gravity differences, is gradually becoming better understood, it remained for the advent of the Keedy ore sizer to make the application of a system of accurate and close sizing of practical importance. Reference may be had to Engineering and Mining Journal, Feb. 5, 1910, "The Keedy Sizer for Classifying Complex Ores."

This machine is based on diametric sizing, that is, the grades are actually measured by the aperture of the screens, limiting each grade, and therefore the ratio in volumes between the largest and smallest particles in any one grade is as the cube of the apertures of the limiting screens. This law, while it is applicable to all minerals breaking into massive particles, is directly affected by the coefficient of fracture. The latter is variable, and as yet extensive investigations have not resulted in determining a suitable factor for each of the usual minerals. Hopes, however, are entertained that something of value in this connection may soon be developed and published. It has been found in practice that the law of cubes gives very satisfactory results and can be relied upon with the exception of certain minerals, such as mica and specular hematite, which break into flat scaly particles, presenting a large area as compared to their volume.

Exception was taken to the cost of sizing an ore into, say, 12 or 15 grades because of the complexity of the apparatus and flow sheet, wear and tear and cost of screen renewals. When considering the old methods of using shaking or bumping screens or reels, the objections are well founded, but are no longer tenable with the more modern form of apparatus. The system is compact, noiseless, dustless and requires but small power. Attention required is at a minimum and screen renewal cost, while varying with the class of material treated, is well within the limits of expense which any given ore can stand if it is worth treating at all.

The objections to the cost of grading in this manner, even though actual operations in a number of instances prove them to be unfounded, still continue and have caused the minds of metallurgists and inventors to seek other means.

NEW SCREENLESS DEVICE.

Recently there have been given to the mining and metallurgical world some details of a new and ingenious device designed to size ore into any number of grades from 10 to 30 without the use of screens.

This new "screenless sizer," in the operation of which the laws of gravity are reported as having but a very slight influence, is capable of some rather remarkable perfrmances, and the published results of an official test will bear some close mathematical analysis. It is barely possible that this machine performs a function as yet apparently not recognized by the inventors or their associates, and if such is true, the apparatus should have a wider range of usefulness than would be accorded to a machine intended to be used as only a sizer.

The measurement of efficiency of any sizing operation is determined by test screening any particular grade through screens which supposedly mark the limits of that particular grade.

In preparing a complex ore for dry table separation it is necessary to make as many sizes as may be demanded by difference in specific gravity between the minerals which vary the least, so that the most perfect stratification may result and that clean zones of minerals, with a minimum of accidental middlings, may arrange themselves on the tables; these conditions can result only when the ratio of volumes between the largest and smallest particles, in any one grade, equals or is less than the ratio between the specific gravity of the two closest minerals.

As an example, in the case of iron pyrite and zinc blende, in which the respective specific gravities are 5 and 4, let Vp be the volume of the pyrite particle, while Vb is the volume of the blende particle. Then

$$\frac{V_p}{V_b}=\frac{5}{4}=1.25$$

As pointed out, grades in which such ratios exist can be produced by considering the apertures of the screens, and if S_1 is the aperture of the coarse screen while S_2 is the aperture of the fine screen, we have

$$1.25=\frac{S_1^3}{S_2^3}$$

Of course, a series of screens from say, 20 mesh to 200 mesh, which throughout would have its aperture cubes bear a relation to each other as 1.25 to 1, leads too far for one sizer and necessitates two machines, as some 22 sizes would be required.

It may be mentioned that in the case of a very complex Mexican ore such a series was employed with the most gratifying results, showing sharp lines of demarcation between the fields occupied by galena, pyrite and blende, so that it was not necessary to cut a zinc-iron middlings.

This, of course, is an ideal condition, but it was found that the system could be much simplified by making only 13 sizes and collecting the accidental pyrite-zinc and zinc-gangue middlings, which, by resizing together over a machine dressed differentially, that is, making between-sizes, prepared them for successful treatment for the reason that the particles were rearranged, and therefore they could not all again report themselves as middlings.

THE McKESSON SIZER.

The McKesson screenless sizer is designed to make as many as 30 grades in one operation, which, if the ratios of volumes between the largest and smallest

particles in any one grade should prove to be as above shown, would be admirably suited as feed for a dry concentrator.

The aperture dimensions of the screens used to test the various grades must be known, but for illustration we may arbitrarily use the following in discussing the results of the official test on the McKesson sizer.

Mesh.	Aperture inches.
24	.0342
28	.0282
30	.0268
34	.0229
40	.0185
44	.0172
50	.0145
66	.0102
82	.0079
97	.0058
116	.0047
139	.0033
172	.0028

The results show that, except in the two coarse grades, efficiency is based on the material reporting in the two heaviest screen products, which, when taken together, show a large volume-ratio between the largest and smallest particles lying between the limiting screens used in determining measure of efficiency.

The results of a test on the McKesson machine making fifteen products are reported to be as follows:

Product No.	Screen.	Per Cent.	Efficiency.
1.	— 24	....	
	+ 30	15.60	
	+ 40	81.20	81.20
	— 40	....	
2.	— 28	....	
	+ 40	93.75	93.75
	— 40	6.25	
3.	— 30	....	
	+ 34	10.92	
	+ 40	50.00	
	+ 44	32.83	82.83
	— 44	6.25	
4.	— 34	....	
	+ 40	28.13	
	+ 44	37.50	
	+ 50	25.00	62.50
	— 50	9.37	
5.	— 40	....	
	+ 44	7.28	
	+ 50	25.00	
	+ 66	64.06	89.06
	— 66	3.12	
6.	— 44	....	
	+ 50	6.25	
	+ 66	68.75	
	+ 82	21.87	90.52
	— 82	3.12	
7.	— 50	....	
	+ 66	37.50	
	+ 82	53.13	90.63
	— 82	9.37	
8.	— 50	....	
	+ 66	9.37	
	+ 82	62.50	
	+ 97	25.00	87.50
	— 97	3.13	
9.	— 50	....	
	+ 66	6.25	
	+ 82	50.00	
	+ 97	37.50	87.50
	— 97	6.25	
10.	— 66	....	
	+ 82	37.50	
	+ 97	46.87	84.37
	— 97	15.63	
11.	— 66	....	
	+ 82	25.00	
	+ 97	50.00	75.00
	+116	21.87	
	—116	3.13	
12.	— 66	....	
	+ 82	15.63	
	+ 97	43.75	
	+116	34.37	78.12
	—116	6.25	
13.	— 66	....	
	+ 82	6.25	
	+ 97	37.50	
	+116	43.75	81.25
	—116	12.50	
14.	— 82	....	
	+ 97	25.00	
	+116	43.75	
	+129	28.12	71.87
	—139	3.13	
15.	— 82	....	
	+ 97	6.25	
	+116	18.75	
	+139	43.75	
	+172	25.00	68.75
	—172	6.25	
		Average........	81.32

The efficiency, determined even in this most favorable manner, cannot be said to be high, and when considering the vitiating effect of the relatively large amount of "through" product recorded, and its detrimental effect on table work, the results cannot even remotely be compared to those obtainable by diametric sizing, when making even a lesser number of products and covering a wider range.

To quote from Metallurgical and Chemical Engineering: "It will be noticed that the grading efficiency in some of the products is lower than in others. but it is claimed that this can be remedied by adjusting the cutters to throw the oversize and undersize into the preceding and succeeding grades respectively, and thereby increase the efficiency of the sizing in all grades."

In the above statement the absence of such positive action as exists when sizing diametrically is clearly admitted.

That the efficiency shown in one grade may be improved by throwing the over and undersizes into the preceding and succeeding grades respectively is obvious, but on the basis of the published screen analyses of the products, instead of thus increasing the efficiency of all the grades, those into which the oversize and undersize are cut would be more likely to suffer, with the result that, while one grade would be improved at the expense of its tonnage, the two grades affected by the improvement of the one would probably show not only a lower efficiency, but would represent a correspondingly larger proportion of the whole. If the action of the machine were positive the explanation of the possibility of improving the grades would have some force which, in view of the results, is lacking.

Taking the basis of the efficiency calculation as given, and applying the laws of cubes, we can calculate the ratios existing between the largest and smallest particle in any one product, giving the machine the advantage of using the screens specified, which limit the efficiency calculation. We have then:

Product No.	Limiting Screens.	Per Cent. Efficiency.	Vol. Ratio of Largest to Smallest Particle.
1.	— 30 + 40	81.20	3.04:1
2.	— 28 + 40	93.75	3.50:1
3.	— 34 + 44	82.83	2.30:1
4.	— 40 + 50	62.50	2.70:1
5.	— 44 + 66	89.06	4.80:1
6.	— 50 + 82	90.52	6.20:1
7.	— 50 + 82	90.63	6.20:1
8.	— 66 + 97	87.50	5.40:1
9.	— 66 + 97	87.50	5.40:1
10.	— 66 + 97	84.37	5.40:1
11.	— 66 + 97	75.00	5.40:1
12.	— 82 +116	78.12	4.70:1
13.	— 82 +116	81.25	4.70:1
14.	— 97 +139	71.87	5.40:1
15.	—116 +172	68.75	4.80:1
	Average ratio............		4.66:1

In the practical application of close and accurate screening we have adopted. as a standard, a series of 13 screens between 0 and 200 mesh conforming to a harmonic series, thus producing 14 products, including oversize and fines. The average volumetric ratio is 2 to 1, while the efficiency, when measured by the screen area usually exposed, varies begrade, averages better than 90 per cent, the only drop under 90 per cent being in the —150 + 200 grade, which, with the screen area csually exposed, varies between 80 and 85 per cent.

The percentage of oversize is practically nil and the particles passing through the fine limiting screen, in testing the grade, are usually of such size as to just pass through the aperture, but much too course to go through the next screen of the series. If the efficiencies in testing the products from the Keedy sizer were figured in the same manner as those for the McKesson sizer products, the former would show an average efficiency of from 95 to 98 per cent, as against 81 per cent for the latter.

The series as developed and used by us as a standard is the following, in which screen cloths have been selected

of apertures conforming with the law of cubes:

Mesh.	Appertures, Inches.	Ratio of Vol. of Largest to Smallest Particle.
20	.0410	1.722 to 1
24	.0342	1.722 to 1
28	.0282	1.783 to 1
34	.0229	1.867 to 1
42	.0183	1.959 to 1
50	.0145	2.012 to 1
62	.0116	1.953 to 1
74	.0089	2.214 to 1
86	.0068	2.242 to 1
109	.0054	1.996 to 1
125	.0041	2.284 to 1
150	.0032	2.103 to 1
200	.0026	1.865 to 1
Average		2.000 to 1

A comparison between these ratios and those of the screenless sizer work, entirely aside from the considerably better efficiency of diametric sizing, clearly indicates which products may be expected to yield the better table results.

The results of the McKesson test show that in a general way the efficiency varies inversely as the ratio of maximum to minimum particles in the grades, excepting in the extreme coarse and fines, but the most important characteristic revealed is the gradual graduation by size almost identical in its character with, but somewhat more emphasized than, that resulting from feeding an unsized pulp over a dry table of the Sutton, Steele & Steele type.

It may be especially pointed out that in every instance in the screen analyses the coarse limiting screen used is of larger aperture dimension than the fine limiting screen of the preceding grade. The efficiency of products 8, 9, 10 and 11 is measured by exactly the same screens, the only difference in the grades being that they grow finer by reason of the fact that the oversize is gradually reduced while the undersize increases. The latter is also true of products 12 and 13.

This fact proves that the products very considerably overlap, and thus the sharp line of demarcation existing between diametrically sized grades is wholly lacking in the new method of sizing. The overlap of the products is graphically shown on Plate I, and it is to be clearly noted that no sharp line exists between any two or even three of the grades, while the overlap, in specific cases, is sufficiently great to completely destroy the effect of sizing. For example, products No. 7 and No. 15 are so poorly sized that —82x97 mesh material is contained in each.

With an average recorded efficiency of but 81 per cent, and that, too, on an average particle ratio of 4.66 to 1, the actual average particle ratio on whole product exceeds 6 to 1, which is far too much to permit of anything like desirable work.

The above discussion is, of course, all predicated on the statement that specific gravity plays an unimportant part in the operation of the McKesson apparatus.

That a machine of this general type will operate as a sizer has been pointed out, but the sizing is of an extremely in-

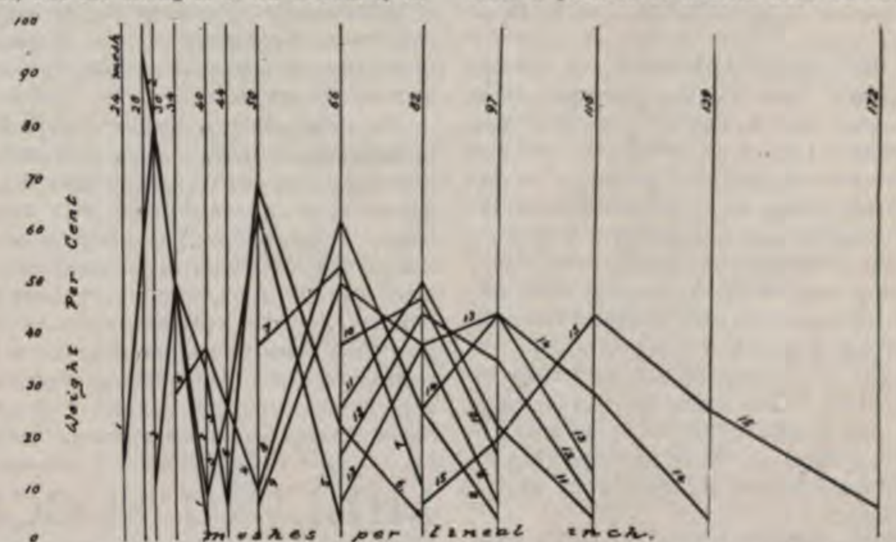


Fig. 1.—Graphical Presentation of Screen Analyses of Product from a McKesson Screenless Sizer

different quality, and specific gravity actually does play a part well worthy of notice. In one instance, an unclassified ore was treated on a Sutton, Steele & Steele table, primarily for the purpose of noting the sizing effect. The tendency was marked but the gradations along the periphery of the table were so gradual as to be characterized as only an abortive attempt at sizing. The feed to the table and the four products caught at the periphery gave the screen analyses on top of next column which are graphically represented in Plate II.

These results were obtained on a magnetic iron ore, and the products "b," "c," "d" and "e" clearly showed that the finer heavy magnetite particles had a distinct tendency to associate themselves with coarser gangue particles—the result of the ever-operating law of gravity. If 15 products had been cut, the result would have been quite as perfect as that of the McKesson machine.

Mesh.	Feed.	Products B	C	D	E
— 50					
+ 58	1.50	4.1	.10	.25	0
+ 68	.50	2.3	.45	.25	0
+ 90	9.50	16.0	10.00	7.25	2.50
+100	12.00	28.7	13.00	13.75	3.50
+140	14.25	18.0	19.25	14.75	5.00
+163	21.50	10.1	16.25	11.25	6.00
+200	18.00	14.1	24.00	26.75	32.25
—200	20.50	6.5	16.00	24.00	49.00

Another notable instance—in the treatment of a mixture of galena, pyrite, zinc and fluorspar, it was invariably found that the finer galena traveled under the pyrite, the finer pyrite under the zinc, and the finer zinc under the fluorspar. In air, a particle of zinc need be only 25 per cent greater in volume than a particle of pyrite to weigh the same, while a particle of fluorite need be only 25 per cent greater in volume than a particle of pyrite to weigh the same, while a particle of fluorite need be only 30 per cent greater in volume than a zinc particle to weigh the same.

Now these particles of equal weight are acted upon equally, and necessarily produce a middlings which when screened over a cloth of proper aperture results in a concentrated product either on or through, or both, the heavier mineral reporting in the finer product.

MACHINE NOT A CLASSIFIER.

The published screen analyses of the products from the McKesson sizer do not indicate that specific gravity always plays

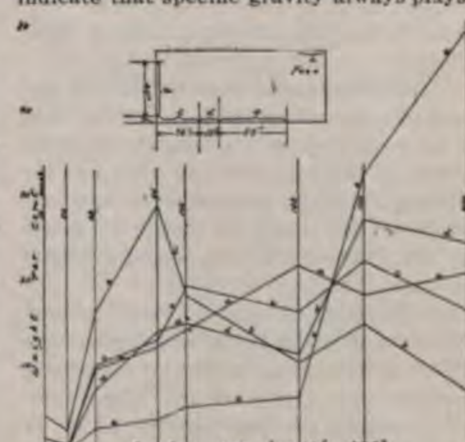


Fig. 2.—Graphic Presentation of Screenless Analyses of Products from a Sutton, Steele & Steele Table, when fed with unsized ore. Small diagram at the top represents the deck of Sutton, Steele & Steele table, showing peripheral discharge of products—b, c, d, e.

no part in the operation, and the question obviously arises whether this machine does not perform a function of

greater importance than the one which its inventors desire to perform. Certain it is, on the basis of the recorded efficiencies and the evident gradual classification of the products, that the name screenless sizer is a misnomer. As far as the usual understanding of sizing is concerned, this machine is not a sizer, as its products overlap far too much. It would be more appropriate to call the apparatus a dry classifier, which in effect it is.

Mr. Charles J. Downey, in Mining Science, Sept. 14, 1911, states: "Concerning the theory of the McKesson method, I have no disposition to enter into a discussion of it, beyond what has already been said. An outline of the laws governing the selective action, in which differences of specific gravity play but a very small part (and then only in the case of widely different minerals, according to the engineers) will be the result of systematic and prolonged experiment. That the sizing is effected to a high degree of efficiency is apparent to an observer, while the operation of the machine has all the aspects of simplicity."

Now going back to the thought expressed above that this machine is essentially a dry classifier, all speculations vanish as to a new principle having been stumbled upon, and viewing the action as one of classification is the more tenable, when considering the analogy between the operation of the McKesson machine and the Sutton, Steele & Steele dry table.

It is difficult to conceive of one making separations between minerals of equal size, on the basis of their specific gravity differences, while the other collects together the various minerals according to their size, regardless of their relative specific gravities. These two thoughts are distinctly contradictory.

If the McKesson sizer acts in the nature of a classifier, which is exactly what a table does (only the new machine by means of the deflectors and discharge arrangement takes advantage of and emphasizes the action, it must be shown by the character of the screen products of each grade.

A hydraulic classifier when making fifteen products appears to deliver a fine string of perfect sizes, however a screen analysis and assays of the screen products reveal the true action, which is classification both by size and specific gravity.

In each grade it will be found that lightest mineral reports, to the greatest extent, in the coarsest grade; while the heaviest mineral will be found, to the greatest extent, among the finer particles of the particular product under consideration.

This same action is to be expected in a machine of the McKesson type.

It can readily be verified by testing a mixed sulphide ore and screen—analyzing the products, just as was done in the reported official efficiency test.

The investigations should, however, be carried further, and each of the screen products should be assayed for the principal metals contained in the mixture, thus readily establishing the actual facts of the operation.

We anticipate that results of such an investigation will show each product to be made up of coarse gangue, finer zinc, somewhat finer pyrite, and still finer galena. If this explanation of the operation of the new machine is found to be true, we will no longer be confronted with a new and paradoxical theory to worry the research metallurgist, but will realize the ease with which appearance may deceive and the danger of a too ready acceptance of an apparent overthrow of fundamental principles that have served us long and satisfactorily.

The development of a dry classifier should have a wider field of application than a sizer, if its capacity is sufficiently high, since, if the machine acts as herein discussed, its products should make an admirable feed for a wet table.

That the new machine is not in any sense a sizer of mixed minerals seems well established, and that it follows the laws of classification in which specific gravity plays an important part is strongly indicated by an analysis of the published results.

We may express a hope that the inventors will shortly supply the metallurgical world with further, more complete data, preferably along the lines suggested, including a screen analysis of the feed to the machine for purposes of comparison, so that speedily a more definite understanding of the principle involved in the performance of this ingenious new contrivance may be had.

MILLING SUCCESSES WITH INEXPENSIVE CANVAS PLANT

By AL H. MARTIN.

Simplicity breeds success. And the adoption of simple ore-treating methods by mine managers has often swerved the point from failure to achievement. The paramount problem confronting the manager of a new property is to make its operation profitable. And too often this aim is defeated by the expenditures for complicated, costly equipment when more simple means may be made to answer with equal satisfaction.

The canvas plant idea is almost as old as mining, and has played a stellar role in the advancement of the industry. Its great merits lies in its efficient recovery of values from mill tailings, the low costs attending its construction, and the economical advantages attending its operation. Employed largely in the California gold districts, where it has attained its greatest development, the canvas table has pioneered the way for a majority of the modern gold-saving concentrators now in use.

Approximately 150 years ago the Cornish tin miner employed blanket troughs in concentration work, and this idea has been employed in many of the foremost gold districts of the world. In the early days of California gold mining, bullock hides and blanket sluices were employed to catch the gold after passing the plates. These devices consisted of an ordinary sluice covered with the hairy hide or blanket. Later heavy woollen blankets were manufactured for this express purpose. The blankets were exceedingly rough and results proved satisfactory. Then an ambitious millman, named Morris, devised incline tables, covering the same with heavy canvas. From this idea dates the canvas table as it is now known in the free-milling gold districts of the west.

In modern California milling, the tailings from the plates first pass to Frue vanners before commanding the canvas tables. This results in a higher and more satisfactory concentration. There are several types and modifications of these tables in use, varying from the most simple design to the Darrow & Hambric patented type. Usually the tables are of two distinct types, the long, narrow design, and the broad tables of comparatively short length. Both types have their advocates, but for general use the short broad table appears preferable, owing to the greater ease with which it is handled by the operator. However, the design is largely a matter of personal choice.

In designing the canvas plant, it is desirable to select a site with a natural slope, giving the tables an inclination of one to one and a half inches per foot. Of course when the natural conditions are unfavorable in this respect, the

builder must construct the plant to provide the required slope. The supporting posts should be sunk to bedrock, to insure solid foundation, as it is absolutely necessary that the original inclination and perfect condition of the floor be maintained. In case it is too far to bedrock, other provisions should be made to insure stability of foundations. The posts are usually treated with creosote or other preserving material to guard against rapid decay. The stringers are usually two by eight inches, or larger, and the flooring consists of pine or redwood planks. Dry lumber is desirable, as otherwise care must be taken in laying planks. It has been found best to lay the dry planks about a half-inch apart, allowing for the swelling of the wood when water is turned on. The surface of planks must be as equal as possible, any deviation from the natural incline militating against best results. The canvas covering is laid over the planks, and lengths of hose provided at frequent intervals to assist in washing down the tables. Generally the tables are equipped with movable strips of wood which serve to deflect the concentrates into the launder running alongside.

Among the most successful canvas plants operated in California was the noted installation at the Empire mine, in the Grass Valley district, and the one operated by the Kennedy Mining company, in the Jackson district. The following is a description of the Empire canvas tables, and illustrates the general style of installation and operation. While this plant has been replaced by the cyanide process, it is representative of most of the successful types in operation in several California fields.

The pulp from the mill, crushed through a No. 7 slotted screen, was received by eight copper amalgamating plates. From these the product passed to two Frue vanners. From the vanners the tailings passed into a settling box, and thence to a battery of 26 canvas tables. The tables were arranged in two lines with an inclination of about 1¾ inches. Each table was 12 feet wide by 8 feet long, composed of a wooden flume covered with No. 8 canvas. At the lower end of each table was placed a 6-inch board, designed to turn the concentrates into the launder built along the discharge end of the table. The board was raised and lowered by means of a long rod extending to the upper end of the table, and conveniently within reach of the operator. At convenient points short pieces of hose were placed, facilitating the washing down of tables every half hour. The product from the tables was received by an agitator, commanding a 6x10-ft. Gates vanner. From this machine the material passed to a second vanner of identical size and type. The second vanner passed the tailings to another blanket concentrator, consisting of two canvas tables 15 ft. square. The tailings from this battery united with the tailings from the first set of 26 tables and the spigot discharge from the settling box; the whole commanding a 22x60-ft. canvas concentrator. The tables handled 80 tons of pulp per 24 hours, and were operated with the waste water from the mill.

At the Kennedy the mill tailings are first received by forty 6-ft. Frue vanners and transmitted by these to the canvas plant. The tables are 12-ft. wide by 13 ft. in length, arranged in a double row. Mode of operation is about the same as pursued at the Empire. After passing the vanners at this plant, the pulp passes into a Gates classifier before delivery to the tables. The classifier divides the valueless coarse sands from the fine product, thus reducing the amount of material to be handled by the tables. It is stated that the coarse sands assay around 60 cents per ton in gold, but the Kennedy management deemed an attempt to recover this as economically impracticable, as fine grinding would be required to release the values. The Kennedy canvas plant is operated steadily and has given excellent satisfaction. As the Kennedy company is the largest producer in California, and one of the most progressive concerns on the mother lode, its satisfactory experience with the canvas plant is a decided testimonial in favor of the economical efficiency of the method.

With few exceptions the canvas table is used throughout the great mother lode, the principal quartz gold producing region of California, and adjoining districts. As a high extractor of slimed sulphides and similar material it has attained particular success. The Darrow-Hambric table, an improved type of the canvas concentrator, is employed at the Zeila, Bunker Hill, Fremont Consolidated and Argonaut, four of the largest of mother lode producers. The system consists of a circular frame, approximating 28 ft. diameter, with six to eight decks or tiers of tables. From 21 to 24 tables are allotted to a deck, each table having an area of 12 square feet. Formerly canvas was employed exclusively, but in the later machines the tables are covered with asphaltic felt, or the plain wooden surface merely painted with asphalt paint and then treated with a coat of fine sand. The inventors state that both of these methods of covering the tables have proven highly satisfactorily, exceeding the canvas as a collective agency. The circular frame is mounted upon an upright axis at the center, the machine being operated by means of an encircling rope receiving power from a pulley, driven by water power. The waste water from the power wheel is employed in cleaning the tables and in other work about the plant. The concentrates are subsequently treated by agitation and cyanide treatment in Pachuca tanks. It is stated that a high recovery is effected at all these plants.

The effectiveness of a canvas plant depends principally upon the maintenance of an even flow of pulp over the surface. The volume of feed must be uniform, otherwise the heavier flow will naturally dislodge and bear away the concentrates previously settling upon the canvas. Consequently care must be taken to maintain a steady and unvarying flow of pulp. The experience of the operator and the character of material treated determines the proper period of time for the pulp to flow over the table.

Cost of plants varies considerably. Some have been constructed for $1,000, while others have cost as high as $7,000. From $2,000 to $4,000 appears a good average. The size of the plant, and the amount of ore to be treated naturally regulates the initial cost; the installation of a plant at a small property being attended with low expense. The location of the property also influences the first cost of construction, the absence of nearby timber augmenting expenditures. A fair quantity of water is required for successful work, the size of plant and amount of material washed regulating the water consumption. But with natural conditions favorable, the canvas plant has proven remarkably efficient.

HANDLING OLD TAILINGS

By J. B. HARPER.*

To those concerned in the treatment of tailing dumps by the cyanide process the accompanying drawing may be of interest, as it illustrates a cheap and rather novel method of filling leaching vats. It is applicable only where scrapers are used to move the material, which should be fairly dry.

The device consists of a bridge with a span slightly longer than the diameter of the vats in use, fitted with wheels or rollers so as to be easily movable along a track from one vat to another, and strong enough to support four horses and scraper filled with sand. The floor-

* Mining Engineer, Denver, Colo., in Mining Science.

ing made with plank set vertically 2 in. apart acts as a grizzly. Aprons at each end give the horses an easy approach, serving also in keeping the track clear of sand and the bridge solidly in place. Eight-pound T rails are used to hold them in position, and when moving the bridge with pinch bars they are taken off like the gang plank on a boat.

The contrivance was used on a 100-ton tailing plant operated by Messrs. Oastler and Southworth at Dun Glen, Nev. The idea was originally theirs, though I assisted them in working out the details of construction. The drawing shows some slight alteration from the original, which I believe is an improvement.

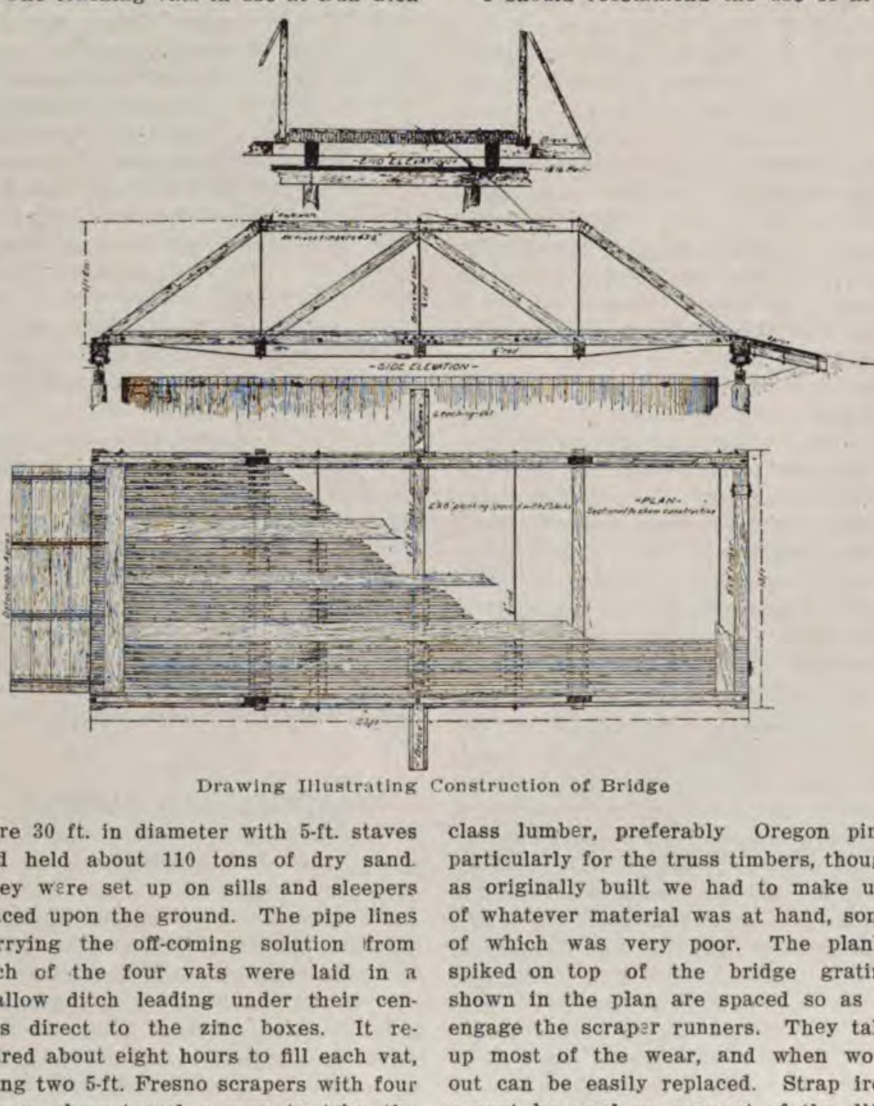
The leaching vats in use at Dun Glen were 30 ft. in diameter with 5-ft. staves and held about 110 tons of dry sand. They were set up on sills and sleepers placed upon the ground. The pipe lines carrying the off-coming solution from each of the four vats were laid in a shallow ditch leading under their centers direct to the zinc boxes. It required about eight hours to fill each vat, using two 5-ft. Fresno scrapers with four horses abreast and a man to trim the sand below the bridge as the scrapers were dumped. The length of haul varied from 100 to 300 ft. Unloading took about the same time as that required to fill the vats, the former being done at night and the latter during the day. Two 2-horse scrapers or "slips" were used for this work, and it is surprising how little shoveling was necessary. Before the first vat was filled dirt or tailing was scraped on the outside nearly to the top of the staves, so as to make an approach for the bridge at both ends; and, because of this, there was no difficulty in driving the teams into the vats, even when unloading the first charge. Only one man was needed to help the drivers. By means of a small suction pump connected to the leaching line moisture in the sand was sufficiently reduced to prevent the horses from miring when unloading was going on.

There is nothing very difficult about the construction of the bridge, and any good carpenter or millwright should be able to build it from the plans and data given.

I should recommend the use of first-class lumber, preferably Oregon pine, particularly for the truss timbers, though as originally built we had to make use of whatever material was at hand, some of which was very poor. The planks spiked on top of the bridge grating shown in the plan are spaced so as to engage the scraper runners. They take up most of the wear, and when worn out can be easily replaced. Strap iron cannot be used on account of the difficulty in dumping the scraper on it.

It was thought that there would be trouble in getting horses and mules to cross the spaced planking, but after the first day there was not the slightest difficulty in that respect.

So far as I know the plant mentioned is the only one where this method has been put into practice.



Drawing Illustrating Construction of Bridge

In testing the quality of iron, if the fracture is found to give long silky fibers of leaden gray hue, cohering and twisting together before breaking, it may be considered a tough, soft iron. A medium, even grain, mixed with fibres, is considered a good sign, while a short, blackish fibre indicates a badly refined iron. A very fine grain denotes a hard, steady iron, apt to be cold and short and hard to work with a file. A coarse grain, with a brilliant crystallized fracture and yellow or brown spots, shows brittleness working easily when heated and easily welded. Cracks on the edge of bar are a sign of hot short iron. Good iron is readily heated, is soft under the hammer and throws out few sparks

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The copper ore of Keweenaw Point, Michigan, was known to the Chippewa Indians, was reported by La Garde in 1636, by the Jesuit missionaries 1632-1672, by Baron Le Houtan in 1689, by P. de Charlevoix in 1721, and by Jonathan Carver in 1765. Captain Carver's report led to the formation of a company which mined copper ore in 1761 and 1762, but failed. Alexander Henry, an Engilshman, mined copper in 1771, but quit in 1774. H. L. Schoolcraft reported on the deposits in 1819, and Major Long in 1823, for the United States government. From 1830 to 1841, Douglas Houghton, for the first Michigan Geological Survey, systematically explored the deposits, his reports leading to the modern development of the region dating continuously from 1844. In that year a few tons of oxide, not native copper, were taken from a fissure vein near Copper Harbor, Keweenaw county, by the Pittsburgh & Lake Superior Mining Company, which later developed the Cliff, mine, 20 miles to the southwest.

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Monel metal is a "natural" alloy of copper and nickel of the following approximate compositions: Nickel, 68 to 72 per cent; copper, 26.5 to 30.5 per cent; iron, 1.5 per cent. It is made directly from the nickel-copper matte of Sudbury, Ontario, and is regarded as a successful substitute for steel and bronze in certain important uses. It has recently been cast in pieces weighing as much as 25,000 lbs., most of these having been for propellers that are furnished to the United States government. The demand for wheels of this material is said to be increasing. A prominent naval vessel which has recently been equipped with monel metal propellers is the battleship Rivadavia, launched for the Argentine republic.—Mining Science.

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Grade resistance is usually figured at 20 pounds per short ton for each per cent of grade.

Mines and Methods

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Guggenheims "Goldbricked"

How the Famous Family's Ship of Fortune Recently Has Been Recklessly Steered and Severely Buffeted by the Winds of Adversity

Horace J. Stevens, copper statistician and author of the Copper Handbook, in an elaborate address delivered before American Mining Congress at its recent session held in Chicago, and printed in full in the last issue of Mines and Methods, vigorously assailed the Government's "conservation" regime in Alaska and incidentally—though perhaps inadvertently—dealt a killing blow to the copper mining feature of the Guggenheim Copper River railroad enterprise.

For years the copper-producing world has been kept in a sort of "cold sweat" by the fabulous tales that have from time to time been told regarding the magnitude and richness of the mountains of almost pure copper which it was claimed existed in the Copper River region of Alaska, all owned or controlled by the Guggenheims, and to become available on completion of this, the most difficult, daring and expensive railroad enterprise of any age or people. But, as indicated several months ago by this journal, there never was any real cause for apprehension that any possible production of this forbidding region would ever seriously embarrass or disturb the actual metal industry excepting through such fictitious fluctuations as might arise from manipulations of the stock market. And now, all hope of the harvest of other people's coin—which seemed almost within the grasp of realization from the flotation of "convertible bonds" and shares which were soon to have been offered to the impatient public investor—has been knocked into "smithereens" by an innocent slip of the historian's unguarded tongue.

After an exhaustive and masterful review of the copper metal producion industry, from its inception in this country some fifty years ago, in which he displayed remarkable familiarity with his subject, Mr. Stevens trained his batteries upon the Government's "conservation policies" as applied to the great Alaskan coal fields, and in pathetic language recounted some of the trials and tribulations endured by the Guggenheims in their patriotic efforts to develop the resources of that far off region. On this subject, Mr. Stevens said:

A "COPPER PLATED GOLD BRICK."

"The Guggenheims are the bogey-men with which the conservationists most frequently alarm the public. We have had it dinned into our ears, by innumerable patriots seeking office, and repeatedly set before our eyes, in every yellow newspaper and muckraking magazine, that 'the Guggenheims are stealing Alaska.' As a matter of fact, the Guggenheims control a copper mine in the interior of Alaska, that is a wonder in its way, YET WHICH CANNOT BE RATED AT MORE THAN A THIRD-CLASS PROPERTY. This mine, the Bonanza, is a sort of copper-plated goldbrick, in that an interior core of limestone is surrounded by phenomenally high grade bornite and copper glance. No competent mining man who has visited this property ever has estimated the amount of ore in sight, and safely to be inferred, as capable of yielding more than 100,000,000 pounds of finished copper, a total production equivalent to only one year's maximum output by any one of the six leading copper mines of the world.

"In order to get this ore out of a wilderness, the Guggenheim interests have built the Copper River & Northwestern railway, a line of 195 miles length, variously estimated to have cost from $13,000,000 to $25,000,000. The gross value of all the copper contained in the Bonanza mine, taking the outside estimate of tonnage, is considerably less than the lowest estimate of cost of this railway, and the net profits derivable from the Bonanza mine, cannot, by the most liberal figuring, be estimated at more than $4,000,000 to $5,000,000. Instead of being commended for their enterprise and courage in building this railway through an arctic wilderness, the Guggenheims are held up to public scorn as thieves and robbers. This railway cuts through workable beds of coal, but is prohibited, by the federal authorities, from developing or using this coal, and is compelled to import inferior coal, from British Columbia, at a cost more than double that of domestic coal, if its mining were permitted. Not only does the railway suffer from this arbitrary action by the federal government, but the 50,000 unfortunate American citizens who live in Alaska are compelled to pay double or triple the price they should pay for fuel, through the efforts of the conservationists, backed by the federal government, to 'save' the coal for some future use, at an indefinite date. * * *

"The reformers, as these gentlemen term themselves, are advocating the government building and operation of railways in Alaska, and the government ownership and operation of coal mines, which is state socialism pure and simple, and any man seriously advocating such a policy is a socialist, no matter what he may choose to call himself. It is further advocated by the junior senator from Wisconsin, and his official and unofficial organs, that the government also should buy the Copper River & Northwestern railway from the Guggenheims. Doubtless the Guggenheims will be very glad indeed to sell their railway, which is threatened by tidal floods and glacial floods, with its principal bridge across the Copper River threatened by a glacier itself, but it is difficult to see where the long-suffering taxpayer will benefit by such a purchase."

SIDE-LIGHTS ON SITUATION.

It should not be inferred that in exposing the certainty of an early collapse of this unfortunate venture, Mr. Stevens had any thought of "knocking" or blocking probable future attempts of the Guggenheims to recoup their loss by the usual method of bond and share flotations. On the contrary, it was clearly his design to clinch his denunciation of the Government's acts in intercepting the Guggenheim "coal land grab" and thereby enlist the sympathy of the public in behalf of those gentlemen because of the great loss they had sustained by reason of failure to get away with these valuable coal fields, in addition to being "buncoed" in their copper mines and railroad investments; though in the latter case they were following the advice of the "greatest mining engineers in the world."

Of course the good people of Alaska are much disgruntled at the failure of the Guggenheim-Cunningham-Ballinger-Pierce land piracy—regardless of the future monopoly they were fostering—because, for a time at least, it meant the expenditure of large sums of money in that immediate locality, and greatly increased industrial and speculative activ-

ity throughout the entire region, thus affording resident citizens innumerable opportunities for thrift. But, like the people who inhabited the region traversed by the Union and Central Pacific railroads, they were willing and would have been glad to see the most valuable possessions of that entire region given away if thereby an opportunity for immediate temporary gain were afforded.

And so, in the case of construction of the Union Pacific, no one thought of the empire of choice lands that were donated to the projectors of that great enterprise, in addition to sufficient money to have built a double-track line for the entire distance covered. But, in later years, when they came to realize that every person, article of produce or merchandise that was transported over these lines was taxed to the very limit of endurance, (all local traffic being charged full through-rates to the west coast and back to destination), many have been heard to curse the day that those roads were conceived.

PLANS THAT WENT AWRY.

Recurring to the Copper River railroad and mining enterprise: From their well known methods of financing their undertakings, frequent expressions of surprise have been heard that the Guggenheim Brothers have not long since sought to draw from the public the necessary funds with which to handle the business by means of the issue and distribution of convertible bonds and shares. But the reason for not doing so is plain.

At first they thought they possessed the greatest copper mine in the world, and naturally wanted to keep it all in the family. In truth, they made no effort to conceal the fact that they expected thereby to actually control the copper metal markets of the world—for had not the greatest engineers in the world told them so? And, besides, upon such assurance they had enlisted the house of J. P. Morgan in the enterprise, and therefore no further financial help or division of profits was desired. It is well understood, however, that the rounding out of the enterprise contemplated the inclusion of the coal mines in the railroad-copper mines combine, whereupon the flotation of a $100,000,000 convertible bond issue would have seemed extremely modest and in fact would have been much more conservative than many other of their offerings.

With Brother Simon in the United States Senate, and chairman of the public lands committee; with Ballinger and Frank Pierce at the head of the Department of the Interior, and Cunningham in charge of the small army of hired entrymen in the field, the situation for a time seemed most promising. But luck was against them, likewise the blatherskite Pinchot, and finally the President took a hand, with the result that the scheme was "cooked to a frazzle." And now comes the copper historian, Stevens, and declares that the ultimate net profit derivable from those great Copper River copper mines "CANNOT, BY THE MOST LIBERAL FIGURING, be estimated at more than four million or five millions of dollars," whereas the actual cost of the railroad to date is estimated at from thirteen million to twenty-five millions of dollars.

SIMON'S PATRIOTISM WANES.

Having failed in the purpose for which he is said to have bought a seat in the United States Senate, Mr. Simon Guggenheim has announced that his business interests make it imperative that he shall vacate that seat and resume more pressing duties, wherefore some people may wonder what he meant when he said, upon entering upon his candidacy for the Senate, that he had "disposed of all of his business interests and if elected would devote his entire energies and time to the interests of his constituents and the public." But this is unimportant. Now Simon knows that both he and the country have had enough, and he will retire wiser, though poorer and sadder.

As to the rest of the "retiring bunch," Frank Pierce at least appears to have improved both in worldly possessions and native cunning, so that the firm of which he is star member has found it expedient to extend the field of its operations to the oil regions of California, where Mr. Pierce should find profitable employment in a congenial atmosphere. And as to those "Great Engineers" who steered the hapless Guggenheims against the Copper River "GOLD BRICK," one at least—Mr. A. Chester Beatty—now counts his dollars with seven figures and, as we are informed, has since opened an office in Bankers' Row, London, where he will doubtless find a new crop of "suckers," in the meantime awaiting the result of an action now pending before Justice Gerard, of the Supreme Court, New York, wherein Mr. Beatty is seeking to collect from his former employers the sum of about $700,000 as the price of options conveying a portion of these Yukon properties.

YUKON "GOLD BRICK."

But the mistake and misfortunes into which the Guggenheims were lured by these great engineers are not limited to the Copper River "Gold Brick." The "Yukon Gold" promises to be equally unprofitable. In this case, like the Copper River venture, the promise of profit for a time seemed to be too good to admit of any portion being offered to the public (not even Morgan was allowed participation) until some fifteen millions of hard-earned dollars had been dumped into and filtered through the stupendous engineering schemes that had been planned in the New York offices of these great engineers and which they promised would yield more real gold than Solomon ever dreamed of. But in course of time —as in case of the Copper River "gold brick"—the cold fact began to dawn upon the Guggenheim Brothers that, although there was much "glitter," very little gold had come into view. And the panic of 1907 was still on in full force. The capital stock of the company at that time consisted of three million shares, par value $5, or fifteen million dollars, all issued and fully paid, being 500,000 shares for each of the six brothers participating, one (Benjamin) having—as we are informed—withdrawn from mining investments. The "Nipissing deal" also had just put an ugly crimp in their exchequer, so that there was urgent need for other people's money—in fact, the "boys" were "all in."

Then it was that an additional issue of 500,000 Yukon shares was determined upon and Tom Lawson was called in to dispose of the block at $4.50 per share net to the corporation. As nobody else had any shares, Lawson found it easy—by his methods—to "wash" quotations up to $8 and better, and it was reported that about 140,000 shares were disposed of at prices ranging from $5.50 to $8; but this stock practically all came back within a few days, so that, after a campaign of a few weeks, Mr. Lawson found himself again in possession of the entire issue and minus considerable cash because, in order to support the "boom" he had started, it became necessary to take all offerings at advancing prices, the final result being that the six brothers were compelled to supply the cash and keep the entire issue of 3,500,000 shares in the family, bringing their total investment up to $17,500,000.

The property has paid in dividends to September of this year $3,150,000, a return of a total of 18% of the original investment, and it is not believed that this sum will be duplicated during the entire future productive life of the property. But the eminent engineers who "turned the trick" are still in affluent circumstances.

THE BRADEN FLOTATION.

In addition to th foregoing our friends, the Guggenheim Brothers, have some other enterprises to their credit which give promise of similar results, all promoted by the same corps of eminent engineers, prominent among which is Braden Copper, located in the province of O'Higgins, Chile. The ores are of the same general character as those of the so-called porphyry deposits of Utah, Nevada and Arizona, and the ground—oper-

ated by natives—had for many years been productive of considerable quantities of high-grade ores which occurred in small, irregular seams which had been pursued in depth as far as any profit could be realized therefrom. But the property for years had been practically deserted until it was picked up by the Guggenheims at a comparatively nominal cost and incorporated with a nominal share capital of $6,000,000, divided into 1,200,000 shares of the par value of $5 each.

Strenuous efforts were made to distribute sufficient of these shares to return the purchase price and provide a development fund, and also to equip the property with reduction works of moderate capacity; but owing to the unsavory character of the "Nipissing deal," which was pulled off at about that time, the public refused to follow the Guggenheims and their engineers into that far-off and uninviting region. So that, to make the scheme more attractive, the usual method of convertible bond issues was resorted to, with the hope of securing from the public the necessary funds. A portion of these issues were listed on the London Stock Exchange and also on the New York Curb, but with indifferent success in all cases. As a result, the burden of carrying the entire flotation fell chiefly upon the Guggenheim Brothers themselves. There has been four installments of these convertible bond issues—of $2,000,000 each—making in all, to date, $8,000,000. The first three issues bear 6% interest, though this rate was increased to 7% in case of the last issue. But the increased rate seemed to render the bonds even less attractive than those bearing the lower rate.

An explanation of the lack of confidence on the part of the public in this "flotation" will be found by reading "between the lines" the latest report of Pope Yeatman, which was recently given to the public through the usual publicity channels. Possibly in the course of a year a considerable portion of the outlay may be returned, but at present and in the meantime the Guggenheims, in following the advice of their ex-engineers, have added probably nine or ten more millions of dollars to their Alaskan burdens, which must swell the total amount of these unproductive and unrecoverable millions well above the FORTY mark, without having scored a single winner.

Naturally the investment of this vast sum in unproductive fields must produce severe stringency in other channels, which no doubt in part will account for the announcement contained in late New York dispatches to the effect that "Daniel Guggenheim, Murray Guggenheim and Edward Brush have retired from the National Lead Co.," otherwise known as the "lead trust." This corporation was formed some fifteen or more years ago by the Guggenheim Brothers, and through it they have maintained a complete monopoly of the lead manufacturing industry ever since. They have drawn down in dividends from its operations over $24,000,000; but the time having come when they needed quick money they have no doubt disposed of their holdings, and hence retired from the directorate. And now that the Senator has resigned an unprofitable and uncongenial position, the brothers will doubtless get together again and endeavor to recoup their scattered fortunes—and in the future it is likely that they will not require so many nor such high-priced engineers.

It might be thought that, instead of parting with National Lead, the Guggenheim Brothers would have disposed of Utah Copper shares, of which they have very large holdings; but that would have been impossible for the reason that all of their shares in that issue, together with those of the other "inside" holders, have been securely locked up in a "selling pool" for the past four years—as previously shown by this journal—and it has been impossible in the meantime to work up a public demand for these shares. Of course liquidation of the pooled interest has been impossible. Besides, in order to preserve the entire proceeds derived from the sale of the mine's product for distribution as dividends, the burden of providing funds to meet the "stripping" costs, as well as the construction of the Bingham & Garfield railroad has fallen upon the "pooled interest," so that as a result, and as previously stated in this magazine, A BOND AND FLOATING DEBT OF ABOUT $11,000,000 NOW BEING CARRIED BY THE POOLED INTEREST, stands between the individual members thereof and any possible profit that may hereafter be derived from the "distribution" of pooled shares.

AN ECHO OF YUKON GOLD

Before Supreme Court Justice Gerard, Thomas W. Lawson of Boston testified that in order to raise $3,000,000 the Guggenheim Exploration Company capitalized the Yukon properties in Alaska at from $17,500,000 to $25,000. He was engaged to float the stock by advertisement.

Lawson testified for the plaintiff, Alfred Chester Beatty, mining engineer, who sued to recover about $700,000 as his reward for having passed his options over to the company. Delays in settlement caused the suit.

When the Guggenheim company obtained the property Lawson talked with Daniel and Sol Guggenheim about letting the public in on the stock. He testified that the large outstanding interest bothered him, as he feared he might be fed with the stock of insiders if he made a good market. The Guggenheims promised to keep their stock out and also that of Engineers Treadgold and Perry, but it was thought best not to take Beatty into the pool and Lawson was unable to learn how much stock Beatty held or was entitled to hold.—New York dispatch in Boston Financial News, Dec. 20, 1911.

The memory of Mr. Thomas Lawson is at fault wherein he indicates that the nominal cash capital valuation of the "Yukon Gold" was raised from $17,500,000 to $25,000,000. The exact facts in this regard are as stated by us in the article preceding the above item of court news from New York.

EXPLORING DREDGING GROUND

By AL H. MARTIN.

Most of the failures attending dredging in late years are directly traceable to careless or incompetent examination of deposits. To be economically successful the territory must be sufficiently extensive for the type of boat designed, and must necessarily contain sufficient gold values to justify the large expense attending preliminary arrangements. As in many other branches of the mining industry, the tendency has frequently been to undertake the construction of a costly dredge before resources were comprehensively demonstrated. As modern dredges cost all the way from $50,000 to $250,000, it is readily apparent that resources must be ample to justify initial expenditures.

In prospecting dredging ground many elements enter into consideration. A deposit may contain comparatively high gold values and yet prove unprofitable because of hard rough bedrock; presence of huge boulders; abundance of clay, etc. The principal factors, however, consists of sufficient ground, good gold content and fairly favorable economic conditions. Exmination of dredge holdings should be under the supervision of an engineer skilled in this branch of the mining industry, as one of little knowledge of the difficulties attendant upon the dredging practices would be apt to find unexpected problems suddenly developing.

In California dredging has been brought to a particularly high standard, and the modes of prospecting prevalent in California districts are favorably regarded by operators of other fields. The general practice is to sink a number of small prospect shafts, or conduct explorations with Keystone drills. Testing deposits by prospect shafts is considered the most satisfactory method, but this

mode is restricted to favorable localities. A great percentage of California dredgable ground has been proven by the Keystone drills ,and this methodd is applicable to all districts, even with most adverse conditions regnant.

Round shafts are usually employed, with a uniform diameter from surface to bedrock. For shafts of approximate depths of 30 feet the diameter is usually three feet. For shafts of 50-foot length or deeper the diameter is increased to 40 inches. When shafts are sent down in wet ground round iron caissons are generally employed in place of lagging. These caissons are usually installed in four-foot sections. However, when the ground is so loose or wet that considerable timbering is required, shaft sinking soon becomes too expensive and is replaced by drill holes. Under favorable conditions the cost of shaft-sinking runs from 50 cents to $2 per foot, but when timbering is required costs run high. California operators generally employ the shaft-testing method only when conditions are favorable, as timbering of loose ground proves too costly. At times the entire amount of material taken from the shaft is washed and sampled, while in most instances a small portion of the material is taken sectionally from surface to shaft-bottom. The great advantage claimed for the shaft method of testing gravel deposits is less liability to error if extracted material is carefully handled. In drilling, a careless runner by failing to keep the pipe well ahead of the bit allows the pumping out of an excessive quantity of materials when the drillings are extracted. This, of course, results in indication of higher values than the deposit contains. If the pipe is driven too far ahead of the drill, particularly in loose ground, the drill pipe is liable to become clogged and not sufficient material is removed to indicate the real value of deposit. Elements like these naturally compel the exercise of constant care and require the employment of skilled runners and engineers.

The Keystone No. 3 traction drill is employed by most California operators. This machine is usually equipped with an 8 or 10-hp. boiler, and drives the drill by means of a walking beam. Of late years the boiler is being replaced by a motor, as the main dredging fields are well supplied with electric power. When the boiler is used, wood, fuel oil and coal are burned, the class of fuel depending upon the locality. Six-inch casing is usually employed, divided into five to seven-foot sections. The sections are added as additional pipe is required. Occasionally drilling has been accomplished in hard ground with the employment of casing, but the practice is extremely dangerous, as the core can not be considered as truly accurate. And when the ground is sufficiently hard to drill in this manner it may also prove too difficult to be successfully dredged. This is a feature commanding the attention of the examining engineer as a too difficult ground means complete failure, no matter how high the gold values may be. This fact must be determined before the construction of a dredge is recommended, not afterwards.

Drillers recommend the employment of a slender bit when testing sand or gravel, with quick long strokes favored. This prevents a settlement of material between strokes, with the re-cutting of material, loss of time, and possible loss of gold. In this mode of drilling the machine delivers 55 to 60 strokes per minute, with each stroke over 36 inches long. When the bedrock or large boulders are drilled a heavy rock bit, with a wider cutting edge is used. In all instances it is advisable to keep the drill sharp to prevent a possible flouring of the gold.

A vacuum pump, composed of a steel cylinder equipped with a piston rod surmounted by a valve is employed to extract material from the casing. When working above water level, or in dry ground, some water is constantly kept in the casing to assist pumping and facilitate drilling. Pumping is usually done after drilling a foot, although some operators send the drill down several feet before resorting to the pump. Pumpings are repeated until all material in pipe to within a few inches of end of hole is withdrawn. Usually two or three pumpings suffice for each foot put down, but this varies with the character of material. The extracted mterial is discharged into a pan placed in the sample box, washed and the gold values recorded. The tailings and material escaping from pan into the sample box are placed in a tub and treated by rocking. The fine colors from pan and rockers are kept in a small dish and amalgamated at conclusion of work. The amalgam is usually kept in a vial and the quicksilver later parted from the gold by nitric acid, after which the gold is washed, dried and weighed. Other operators avoid the use of quicksilver by separating gold from the black sands by magnets and close panning. Every endeavor is made to carry on sampling, amalgamating, etc., under identical conditions as prevail on dredges in actual practice. By this means over-valuation of the material is avoided, and the results obtained are accurate.

Costs of drilling varies in accordance with existing conditions, the more difficult ground naturally resulting in heavier costs. Under favorable conditions drilling costs generally range from $1.50 to $2.50 per foot, but this may be increased by accidents or the encountering of particularly refractory deposits. It is imperative that a large number of holes be sent down in order to gain an accurate record of the value of deposits. In every instance the greatest care is required to prevent over-valuation. In considering the value of a deposit many engineers base their calculations on 75 to 80 per cent of the total value shown by the prospect drills or shafts, considering this a safe figure. However ,experiments prove that actual results vary considerably from tests, although careful work largely eliminates the element of risk.

The life of a dredging enterprise is restricted to proscribed confines. The experienced engineer knows how much ground will be handled and the approximate value of the total recovery. Unlike a quartz mine, there is no possibility of profitable existence beyond the developed resources. Consequently, in considering a dredging proposition the profits in sight must be sufficient to return the entire amount of capital invested, with a good rate of interest added. California operators generally consider 10 per cent as the minimum rate. An acre of ground 33 feet deep contains 53,240 cubic yards, which allowing for loss in operation, would mean the handling of 50,000 cubic yards by the dredge. One hundred acres would embrace about 5,000,000 cubic yards of material, or sufficient to keep a medium-capacity boat in commission for about four years. The more extensive the area the greater becomes the ultimate profits, provided values are fairly uniform throughout. And the more material handled the lower is the cost per cubic yard.

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Selenium is a rare and little known element described by the United States Geological Survey as having its greatest use in the manufacture of certain glasses to which it gives a red color and in coloring enamel ware red. It is used to overcome the natural green color of ordinary glass and also in making glass of a distinct red color such as that used on railroads for signal lights. Selenium has the peculiar property of being a very poor conductor of electricity in the dark and a fairly good conductor in the light, and a number of electrical inventions depend on this peculiarity. It has been used in experiments in telephoning along a ray of light, and for transmitting sounds and photographs from one place to another by means of a telephone or telegraph wire.

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As the strength of concrete depends largely upon the thoroughness of the mixing, great care should be exercised in this respect.

Mines and Methods

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CONTENTS:

Seventy-seven United States Circuit Courts will go out of existence on Jan. 1. This is only one of the reforms provided for in the new judiciary code enacted by Congress last March. Since the Circuit Courts of Appeal were organized in 1891 the existence of the old Circuit Courts has been regarded as superfluous and expensive. Twenty-nine circuit judges will lose their benches but they will continue to sit in the Circuit Courts of Appeals and help out in the District Court. All the clerks of the Circuit Court will see their position abolished. The new code makes the salary of the chief justice of the United States Supreme Court $15,000 a year and each associate justice $14,500. Jurors for federal courts hereafter will receive their summons by registered mail instead of being personally served by marshals. The new code contains a provision to prevent members of Congress from practicing before the Court of Claims here.

UTAH COPPER IN PARIS

In its review of the copper share market the Paris Globe of November 30 comments on Utah Copper. Translated the item reads:

"It was certain that the introducers (promoters) of this property would try to profit by the awakening—durable or passing—of the coppers to resume the sale and consequently place their titles (shares). It is for that reason that the Utah Copper stock, the sale of which had fallen into oblivion, has briskly awakened and advanced to 275f ($55.10). It would be useless to point out the dangers of these intermissions (ups and downs) or the particular conditions under which the Utah Copper shares find themselves again admitted to our market, for the buyer is bound hand and foot to the good pleasure of the introducers. They will sell their titles (shares) and buy them in again, when it pleases them, at their own prices."

This is the first mention the Globe has made of Utah Copper shares in a long while. The item is evidently intended as a warning to the French investors that if they "monkey" with Utah Copper again, they may count on getting their fingers burned, as they did following the first listing of the 300,000 shares of individual stock at an expense to the company of $250,000—according to newspaper reports at the time—about two and one-half years ago. The Globe's statement that the shares have "again been admitted to our market," would indicate that after the sale of the something over 2500 shares to about 2100 French patrons of the market at and around $56 a share—and the succeeding slump—the "introducers" and their wares had been bundled out into the street. Mines and Methods told how all these shares had found their way back into the hands of the "introducers" at the cheap prices and now the Globe warns the French people that, with the opportunity afforded in the better price of copper metal, these "introducers" have again secured recognition on the Bouse with the evident purpose of repeating the original performance. The Globe is evidently awake to the fact that it is within the power of the "introducers" to make and break the price of this stock at will—to fictitiously advance the market price for selling purposes and likewise put it down when they want to buy—thus making it possible to reap a harvest from the Frenchmen going and coming.

The would-be French investor should not overlook the fact that when the 300,000 shares were listed in Paris two and one-half years ago, all of the capital stock had been distributed. Since that time the number of shares have been increased from 750,000 to 2,500,000. Of the extra shares authorized about 900,000 are still unissued and available to supply any demand that the management may be able to create. In addition to this reserve stock the company also had, when the recent upward turn in the market was effected, about 85,000 shares of the 160,000 shares set aside for money-raising purposes to be sold at $50 a share and of which 75,000 was converted into cash about two years ago. It is believed that a considerable amount of this remaining 85,000 shares of stock has been shoved on to the market since the rise in order that a better financial showing might be made when the forthcoming annual report is made up, and to relieve the heavy strain of the burden now being supported by the "pooled interests"—as shown in a previous issue of Mines and Methods—resulting from advances made to carry these costs against a time when the price of shares might be advanced and the load shifted to the public.

IS IT WORTH WHILE?

Since the adjournment of the American Mining Congress and the promulgation of the various resolutions adopted by that body aiming at the betterment of conditions under which mining is carried on, technical and class journals are beginning to discuss the propositions set forth by the Congress. The resolution memorializing Congress to establish, under direction of the Bureau of Mines, metallurgical experiment or ore-testing stations for "the purpose of devising methods for the extraction of metals from low-grade ores" appears to have created some friends and some adverse criticism.

Mines and Methods does not wish to say a word that might be construed as being in any sense inimical to the best interests of the industry or those engaged in the business of mining, milling smelting or any of the professions which depend upon mining for existence; and yet, the impression will not down that in the matter referred to the Mining Congress is asking for something which, if obtained, would work more harm than good.

It may be granted that there are plenty of people in the world—including wealthy corporations perfectly able to bear the cost of making their own experiments—who would grasp the chance to have the government supply the talent and do the work for them; but we submit that such a plan would soon destroy the incentive and determination to do which today exists in the ranks of

the mining, metallurgical and mechanical engineering professions.

Into the government laboratories and testing plants would most likely go mainly such degrees of skilled artisans as the "political pulls" or business importance of the particular locality effected would command and, once installed, only changes in the political complexion of the communities would work to dislodge them. A great show of "learning" might be made in the beginning, but it could not last—and while it did the engineer or metallurgist with a method or process worthy of testing would more than likely discover that his education, training and labor of years had all gone for nothing; that effort and research in his particular field, without having the sanction of the "political" engineers in the "public" works, could not secure recognition. And it might be added that no engineer of ability, with a problem personally solved, would care to turn it over to a government concern for the benefit of everybody without commensurate compensation, even if the "works" were inclined to give it a trial.

It seems to us that anybody—either individual or corporation—with complex problems in ore treatment or mining methods to solve can find a way to final solution without the aid of the government. The brightest minds in the metallurgical and allied enginering professions today are encouraged in their work through the knowledge that individual merit is sooner or later recognized; to abridge the field and close the gates of recognition and opportunity against them, would be to pursue a policy that would, in a few years, work incalculable injury to the mining industry. Metal mining is a peculiar business and calls for the widest range of technical skill. Its diversified and extremely intricate metallurgical and engineering problems can never be successfully relegated to solution by public testing works. Banish the thought.

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BROKERAGE PUBLICITY

The exaggerated mining news items published by Chas. A. Stoneham & Co. have bred much mischief, says the December issue of the Canadian Mining Journal. One mining company has adopted the expedient of advertising in the daily papers the fact that it cannot be held responsible for any statements made by Chas. A. Stoneham & Co. It would be a very wholesome thing if every mining company whose shares are listed on Canadian exchanges were to make a similar protest. Unclean parasites, and this describes the firm of Chas. A. Stoneham & Co., could thus be promptly choked to death.

EDITORIAL NOTES

The appointment of Waldemar Linggren as chief geologist in the United States Geological Survey is one that will be enthuiastically approved by every mining man and engineer in this western country.

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The dividends paid by mining companies operating in the state of Utah during the past twelve months aggregate over $9,000,000, or approximately $1,000,000 more than in 1910.

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It is seven long years since the Salt Lake Stock & Mining exchange has been compelled to record as small a volume of business as during 1911. In 1909 over $17,250,000 worth of transactions were registered. For 1911 the total will not be over $4,000,000. However, with two dull years shoved out of the way, the outlook for a lively twelve months ahead is much more encouraging.

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The better prices that have ruled in the lead and silver markets during the past several months has had a splendidly stimulating effect on operations in the lead-silver camps of the West and the coming year should witness a genuine revival of interest all along the line. Alta should show up well and Park City should make a better showing than for several years past. Bingham, Tintic, Beaver county, Pioche and many other camps and districts tributary to Salt Lake valley smelters are counted upon to greatly increase outputs and shipments of ore.

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Last January, when Mines and Methods published the highly instructive and entertaining article on "Unsolved Problems in Geology," by Hiram W. Hixon, a number of vexing errors crept in and an omission of several hundred words, through loss of manuscript, destroyed at least one of the vital points in Mr. Hixon's discussion. Recently Mr. Hixon passed through Salt Lake on his way home from Los Angeles and at that time he was prevailed upon to make the necessary corrections in the article so that it might be reproduced in this issue. So much interest has been shown in the theories advanced b Mr. Hixon in that article, by geologists and scientists in different parts of the world, that we feel certain our readers will be glad of the opportunity given by the article's republication of again going over the subject.

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On the 15th of the present month the Iron Blossom Mining Company, operating in the Tintic district and controlled by the Jesse Knight interests, issued its annual report. To the officers of that company Mines and Methods wishes to offer congratulations and commend the honesty and candor, lucidity and detail of that report. It is a model of excellence in which there is not a suspicion of the juggling of figures. No one, after reading it, has to guess what the profits of operation have been. Every dollar received has been intelligbly accounted for; the costs of mining and development are separately shown and properly apportioned and charged against the separate tons of ore mined with such splendid, clear-cut detail, that "he who runs may read" and understand. Mine conditions are just as clearly explained and discussed. When some of the big companies begin producing such reports they will be entitled to more consideration at the hands of the investing public, because then the purchaser of their shares will have some idea of what he is getting for his money without having to laboriously pry out the "cull'd gem'man" from the woodpile.

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GOOSE TELLS OF GOLDEN EGG

Telling of boundless wealth, illness, privation and hope abandoned in the heart of the Alaskan wilds, a message signed "Frank Wilson" was found tied to the leg of wild goose killed recently by a Granite City, Ill., sportsman, says the Engineering and Mining Journal. The message read:

"July 16, 1910—250 miles due north of White Horse rapids, on Pine creek. Ill since June 15. Feel certain I am going to die. Right arm broken above elbow in falling from side of mountain. Can hardly walk. Flour in cabin, no way of cooking it because of my condition. Two hundred yards up the gulch is a body of almost solid gold—not nuggets, but a solid sheet or vein. It will never do me any good. Winter is near. I will freeze to death. There is no hope for me. I can hardly move in my bed. I came from Memphis, Tenn. My last move before I die will be to call to my side a young goose of wild breed, which I have raised from a gosling. I will tie this message around its neck. When I am dead it will become wild again and fly away."

This story is indeed touching, and were it not one of our hardiest perennials, might start a new rush to Alaska. Those who don't go immediately, however, will be on hand for staking in the goldfield annually presaged by the finding of nuggets in the gizzards of chickens.

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The ultimate strength for ordinary iron castings may be taken at from 15,000 to 18,000 pounds to the square inch.

SURVEYING A MINE WITHOUT INSTRUMENTS

By J. B. HARPER*

An experienced engineer and the best of instruments is the only safe combination to be intrusted with the mapping of a mine, but it sometimes happens in the case of a remotely situated prospect that neither surveyor nor transit is at hand and an approximate map of the workings is badly needed. The method which I shall try to explain will be recognized by any surveyor as merely a crude adaptation of the plane-table. For those without technical training it may be of interest.

We will assume that the man who wants the plat knows nothing of trigonometry and does not even own a compass. All that will be required is a tape line, a 2-ft. square, some stout twine, a few pins and a sheet of paper with a flat surface on which to fasten it—the bottom of a powder box, for example.

Suppose that a raise has been started

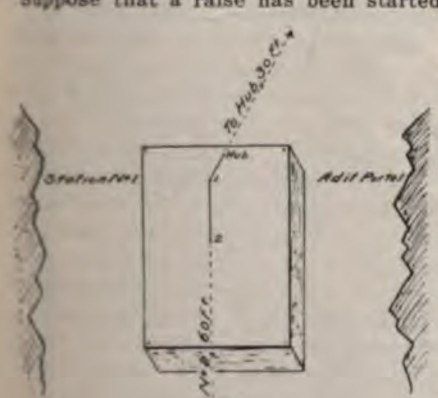

Fig. 1

in a rather crooked adit about 200 ft. from the portal, and it is essential to know about where that raise will come out on surface and how high it will have to be carried above its present point.

Select a place on the dump where there is an unobstructed view of the hill-side cut by the adit, and there drive in a drill. After tacking a sheet of paper securely on the bottom of a powder box place the latter bottom side up at the portal of the adit as nearly level as possible and stick a pin in the paper not far from the edge closest to the dump. (See Fig. 1.) From this pin sight along the surface of the paper to the drill on the dump, and in the line of sight close to the edge of the paper stick another pin. Tape the distance from portal to drill, which we will suppose is 30 ft. Adopt a certain scale for the plat, say 1-16 of an inch to the foot, then that distance on the plat will be 30-16, or 1⅞ in. Draw a line from the first pin to the second and 1⅞ in. from pin No. 1 make a dot on the line and mark it "Hub," being very careful not to move the box.

At the first turn in the adit, as far as

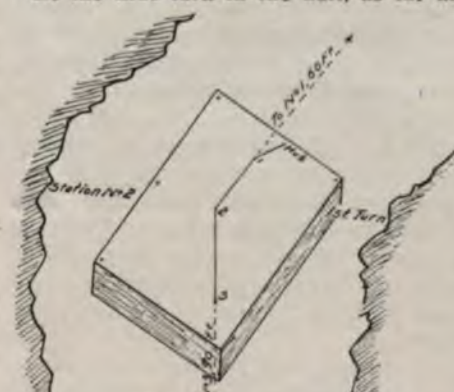

Fig. 2

it is possible to get an unobstructed view of the box, drive a nail into a tie or make some other distinctive mark, and there place a candle. Make sure that the first line drawn still points directly to the drill on the dump, then sight from pin No. 1 to the candle; stick a pin on the line of sight, tape the distance and scale it on the paper as previously; mark that point No. 2. Pick up the box and drive a drill into the ground as nearly as possible under that point on the paper marked No. 1. Move the candle to the next turn and set up the box in the place just occupied by the candle, so that the line drawn from No. 2 to No. 1 will be exactly in the line of sight between those two points (Fig. 2). Then proceed as above at each turn in the adit.

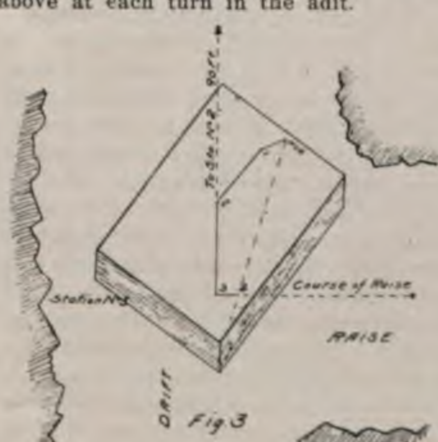

Fig. 3

When the raise is reached its course may be plotted on the box just as the various turns in the adit have been; but it is also necessary to get its horizontal and vertical projections, that is, its length on the horizontal plane (as it would appear on the plat) and its height on a vertical plane. To do this, stretch a string near the hanging wall, giving it as nearly as possible the same angle as the raise from top to bottom. (See Fig. 4.) Suspend a plumb line from the hanging wall and hold a square so that one blade will lie along it and both will project beyond the string. Move it up or down along the plumb line so that the 1-ft. mark on one of the blades will intersect the string along the hanging wall. As shown in the illustration, the lower blade from string to plumb line (C-B) measures 1 ft. and the upper (A-B) 18 in., or 1½ ft. The distance along the string (A-C) is found to measure approximately 21½ in. In measuring this distance it is convenient to stick pins through the string at points of intersections (A and B). From the above it will be seen that in 21½ in. of the raise the vertical projection is 18 in. and the horizontal projection 1 ft. If the raise is 50 ft. long, or 27.9×A-C, its horizontal projection will be 27.9×C-B, or 27.9 ft. Reducing this scale, it will be about 28-16 or 1¾ in. Measure this distance on

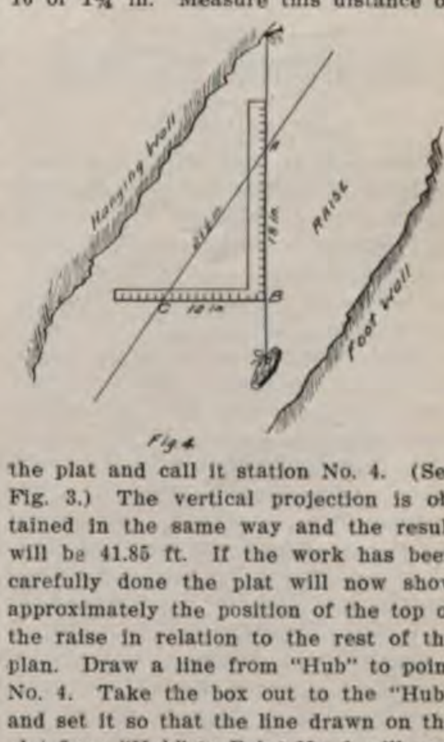

Fig. 4

the plat and call it station No. 4. (See Fig. 3.) The vertical projection is obtained in the same way and the result will be 41.85 ft. If the work has been carefully done the plat will now show approximately the position of the top of the raise in relation to the rest of the plan. Draw a line from "Hub" to point No. 4. Take the box out to the "Hub" and set it so that the line drawn on the plat from "Hub" to Point No. 1 will conform to the same line marked upon the ground by the drills previously set at "Hub" and portal. The dotted line from "Hub" to No. 4 now gives the direction to the top of the raise, and by measuring it the horizontal distance is obtained also. Get the slope of the hillside in the same way that the angle of the raise was measured, but for convenience substitute a straight-edge instead of the string. Calculate the horizontal and vertical distrance as before. To find where the raise will "hole through" on surface, if continued at the same vertical angle, make

*Mining Engineer, Denver, Colo., in Mining Science.

an elevation sketch (see Fig. 5) to scale on a large piece of paper. The illustration (Fig. 5) needs no explanation; H-G at surface, measured on the course of the raise, will give the desired point.

Fig. 5

For brevity in explaining the above I have purposely taken a simple example. The larger the scale and fewer the angles the more accurate will be the result, which at best can be only roughly approximate.

WET ASSAYING FOR GOLD

By G. M. AUSTIN.*

From time to time details have been published of various methods used for the wet assay of gold ores which enable the prospector to carry a portable outfit to a remote district without the necessity for taking a field furnace, crucibles, cupels, fluxes, etc.

With a view to determining the degree of accuracy obtainable with both free milling and refractory ores, the author has conducted a series of tests, using a wet method described by R. De Luce and which is carried out as follows:

About 50 cc. of a solution consisting of 100 parts of water, 2 parts of iodine, and 4 parts of potassium iodide, are added to one assay ton of finely-ground ore in a porcelain mortar. The mixture is ground well for 10 minutes and allowed to stand for 1 hour to ensure the solution of all the gold in the ore. Should the solution become colorless in the meantime, there is an excess of reducing agent in the material and a further quantity of iodine solutions must be added until the brown color remains permanently. The iodine solution is next filtered and the residue is washed, the solution and washings transferred to a stoppered bottle, 3 grm. of pure mercury added and the whole shaken vigorously until the solution becomes colorless. The gold is thus precipitated and forms an amalgam with the mercury, which is transferred to a porcelain evaporating dish and washed with water.

Ten cc. of nitric acid are added and the dish warmed gently until vigorous action commences. The mercury collects as a single globule and dissolves, leaving the gold in a compact bead. The mercury nitrate solutions is next poured off, the gold bead is washed with distilled water if available, otherwise with waters lightly acidified with nitric acid. The gold bead obtained is dried and weighed. Instead of weighing, beads may be compared with standard beads mounted on a card, or after melting, may be measured.

De Luce states that the method is adapted to all ores that can be successfully treated by amalgamation, or by the cyanide or chlorination processes. With certain modifications it may be adapted to almost any ore, and for ores rich in copper he suggests a preliminary treatment with nitric acid to remove that metal.

A method very similar to the above has been described by Dr. F. Jerome Davis, who recommends an iodine solution of exactly the same strength as that mentioned above, and uses 40 to 50 cc. for each assay ton of ore. This mixture is ground in a mortar at intervals for two hours and filtered, 40 to 60 grm. of zinc amalgam being added to the filtrate and the whole agitated freely. The gold is recovered from the zinc amalgam as in De Luce's method.

Dr. Davis states that, in the case of silver ores, ½ assay ton may be taken, the silver being precipitated from the nitric acid solution with hydrochloric acid and weighed as silver chloride.

The following results were obtained by the author from free-milling and refractory ores, containing from a trace to several ounces of gold to the ton.

In each case assays were carried out by the iodine assay, as detailed first in this paper. With a large variety of ores, results may be obtained which are sufficiently accurate for ordinary field work.

Many oxidized ores, containing only a trace of gold, showed this trace quite distinctly. Low results were obtained in every case with basic ores containing manganese. Pyritic ores containing iron pyrites gave somewhat low results, while the simple treatment of pyritic ores containing copper pyrites gave no gold on a 34 dwt. ore; in this case, even after roasting, no gold was obtained, and after nitric acid treatment only 44 per cent was recovered. The telluride ore gave very good results, although it was found that as much as 150 cc. of the iodine solution might be required in order to obtain a permanent iodine color in the solution, whereas 50 cc. was sufficient for most of the other ores. In the case of the ores containing zinc blende and mis
was found to be impossible to
than 75 per cent of the gold by w

A series of experiments pro
be necessary to shake the filtr
mercury until the whole of th
color had been dispersed.

Where many assays are bei
and only one mortar is available,
liminary grinding may be mad
mortar, and the pulp run into a
which it is shaken occasionally
dine solution being added until
color is permanent.

The filtration of the pulp ma
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The mercury used should be e
for gold by solution in nitric aci
amount determined if present.
cial mercury usually contai
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In case nitric acid should not
able for dissolving the mercury,
be volatilized, either in a glass tu
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If the beads are to be measur
ivory scale, it must be remembe
it will be necessary to melt the
before the blow-pipe after they
tained by solution of the mercury

The chemicals necessary for
out 100 assays for gold by this
consist of 4 oz. iodine, 8 oz. p
iodide, 10 oz. mercury, and 1 lit
acid, while the apparatus necess
include iron mortar, pestle and s
preparing samples, ore balance,
wood mortar and pestle, bottles,
glass wool and filter papers, spi
wax lam or candle, porcelain
blow-pipe, small delicate balance
scale.

In calculating the size and str
a hoisting engine for a shaft, i
portant to remember that the d
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Solution, according to Van L.
a homogeneous mixture, the com
of which can undergo continuou
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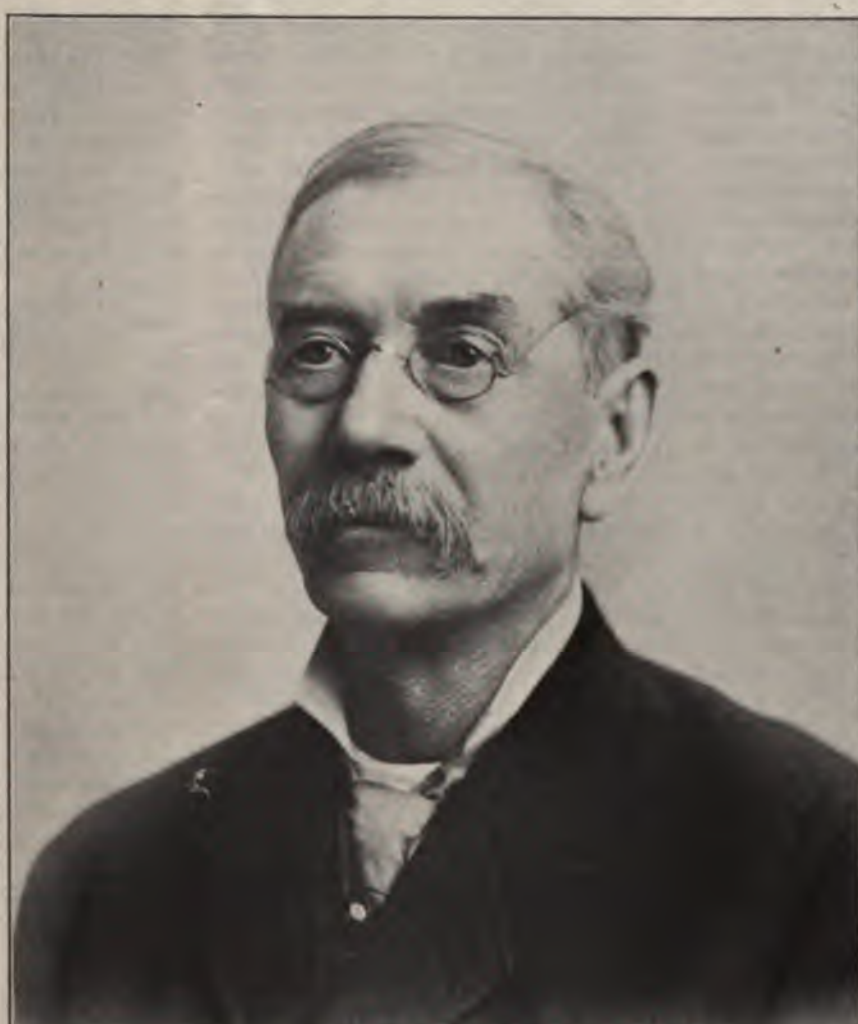
solid homogeneous complex of
substances, whose proportions m
without loss of homogeneity.

* Paper read at meeting of Institute of Mining and Metallurgy.

WALL *vs.* UTAH COPPER

The name of Col. Wall, whose photograph appears on this page, has become a sort of nightmare to the management and pensioners of the Utah Copper Company, in so much that it is seldom mentioned except subjunctively qualified as "the man who for years has been fighting the Utah Copper Company." In fact, so industriously have evil impressions of Col. Wall's pugnaceous propensities been circulated by the victims of his alleged persecutions that his friends have at times been almost led to doubt his sincerity.

Whatever may be said or thought, in this regard, it cannot be denied that, for some time past the courts have been considerably occupied with litigation involving conflicts of interest between Wall and the Utah Copper Company. And, as these conflicts have tended materially to retard the market purposes of the management of one of our "greatest industrial enterprises," it is but natural that the press and the general public should feel and express more or less concern as to the prevalence and final outcome of this litigation in such degree at least as financial interests, or individual sympathies might be affected thereby; and this, without regard to the legal or moral equities involved in such litigation.



COL. E. A. WALL.

But, apart from all this, there is involved in this litigation certain novel abstract legal questions touching the relationship or subordination of mining rights to statutory law of eminent domain which are of vital importance to all investors in mining properties and which we assume may be here discussed without prejudice, or favor to either of the parties to any pending litigation.

MINING A "PUBLIC USE."

By decision of the United States Supreme Court in an action brought by the Highland Boy Mining Company vs. Strickley, "MINING" is declared to be a "public use," in behalf of which the law of eminent domain may be invoked for the purpose of securing right of way for railroads, tramways, etc. The Statues of Utah enumerate a great variety of uses, covering every conceivable necessity which might arise in the operation of a mining property including "dumping ground," for which the lands of another may be taken on formal allegation of necessity, without regard to the requirements of the original owner of the lands. And, although the owner of each individual mining claim in a district may have the right under the Statute to condemn necessary easements through, over, or across the lands of his neighber, as well as the "inalienable right" to develop, mine and extract the ores from within the borders of his own claim, it appears that all these rights may, nevertheless, AT WILL, BY A SINGLE JUDGE OF A DISTRICT COURT, be subordinated or set entirely at naught in favor of the owner of another mining property whose convenience or cupidity might prompt him to devastate or confiscate the property of another. Of course the mining of ores having been declared a "public use" of the land the courts, of necessity, should be empowered to compel, when practical, mutual concessions of easements over and through adjacent lands where existing physical conditions render such easements necessary to the successful mining of the ores. But it would be difficult to conceive of the existance of conditions physical, legal or otherwise — in contemplation of the law of eminent domain — wherein a court would be justified in confiscating or impairing the possession of one miner in order to promote the convenience or enhance the value of the property of another.

Of course, public use, (mining) as herein alluded to— no matter how profitable to the individual so engaged — may properly be required to give way to SUPERIOR public use, but such superiority could only exist in cases wherein A COMMUNITY of individuals, having diverse interests to be served are concerned and demand such use.

A TRAVESTY OF JUSTICE.

To say that a body of men owning a mining property, either as individuals or corporate body, and as such posses-

sing only limited rights of eminent domain may, by the formation of a railroad company every share of the capital stock of which is taken over by the individual owners of the mining property, and in the name of such railroad company and under pretense of serving the public where there is no public, nor even individuals, REQUIRING or desiring such service, thereby secure the confiscation of the mining rights of another, is a travesty of justice and common sense. But such seems to be the intent and meaning of the Statutes of this State as construed by the Supreme Court.

If this result could only ensue after a full trial of each case the proceedings would be less repugnant but, on the contrary the peculiarly accommodating statute PERMITS the judge of a district, at his pleasure, upon application of such a railroad company for a right of way over private lands, to GRANT or REFUSE immediate possession of the premises, with the right to construct and operate the desired railroad, pending the determination of an action at law, whereby such right of way is sought to be condemned.

Before any order granting possession of the lands sought to be condemned, will be issued, however, a formal hearing in open court is ordered by the judge thereof at which the applicant is required to SAY—by witnesses under oath —that there "is public necessity" for the construction of the proposed railroad and that the lands sought to be condemned are essential to its construction and maintenance; whereupon, upon filing of a bond of indemnity in such amount as the court may determine to be sufficient to compensate for resulting damage to the land owner, an order granting exclusive possession of the premises will be issued. In such hearings the defendant is cited to be present and may submit proofs as to the measure of damage that he may suffer by reason of the road, but MAY NOT QUESTION THE ALLEGATIONS OF NECESSITY for its construction, or the lack of public or any desire for its construction, or even the existence of any community or individuals whom it would be possible to serve.

UTAH COPPER'S ACTION.

Proceedings of this character were instituted by the Utah Copper Company about fifteen months ago through its nominal representative, the Bingham & Garfield Railroad Company, by which it has succeeded in securing absolute and exclusive possession of over eighty-nine acres of a tract of ninety acres of mining ground owned by Col. Wall, the surface of the remaining fraction of an acre being shared jointly for "dumping" purposes—by the Tintic (Yampa) Development & Mining Company.

The large photographic insert herewith gives an excellent view of the greater portion of the ground involved showing an interlacing and overlapping net-work of railroad tracks built and in course of construction. The three lower lines to the left have heretofore been owned by the Rio Grande Western Railroad Company but, as indicated by the sworn testimony of Mr. Goodrich—chief engineer of the Bingham & Garfield Railroad Company—these lines have been transferred to the Bingham & Garfield Railroad Company. The "switchbacks" rising up the mountain side to the left lead up from the main line of the Bingham & Garfield Railroad and connect with the various stripping lines which branch out from the Utah Copper Company's three main stripping lines, which enter the main Bingham canyon on the opposite side of the mountain and about fifteen hundred feet distant. The track marked I-K, which is seen to terminate a short distance to the right of the tunnel-mouth shown in the center right of the picture, it is alleged, is to be extended across the property and on westerly to the Bingham and New Haven company's mines, situated on the mountain side opposite that shown in the picture. The distance is about four thousand feet, and the vertical rise about twelve hundred feet.

Three different attempts were made by Wall, by injunction, to intercept and prevent the continuation of this line on the ground that—as planned—its construction would close up the tunnel shown in the picture, and all avenues of approach to the most valuable portion of his property, and completely consume all remaining dumping ground. It was also shown that the Utah company had two other lines completed and in operation—removing waste from its property—and which were situated several hundred feet higher up the mountain, and which extended far out in the direction of the Bingham & New Haven mines and that, therefore, the construction of an additional line for the purpose claimed was wholly unnecessary. Besides, the Bingham & New Haven Company already had long since completed and in operation a tramway which afforded all desired facilities for transportation of its ore. And further, it was alleged that the B. & G. R. R. Co. had no real intention of building the road beyond the boundary of Wall's grounds, and that the sole purpose of its construction was to dam up the gulches and afford storage for the "waste-overburden" of the Utah Company's orebodies.

In respect to this view of the situation, it may be here observed that practically no cuts are made in the construction of any of the lines. In crossing the gulches temporary tracks are first laid from the highest points on the ridges along the contour of the surface out to the center of the gulches. When the overburden from the Utah ground is hauled with dump cars to the end of the track and dumped into the gulches, the tracks are shifted out toward a straight line until the gulches are filled up on a level with the tops of the ridges. These fills in several instances are more than 100 feet in depth beneath the finished grade, and from 400 to 700 feet long, thus forming level fills above the tracks of 200 to 400 feet in width; and in this manner storage room has been found already for probably more than six million tons of Utah overburden, and it is estimated that when the entire "system" of roads and back-switches that are planned shall have been completed, AS PLANNED, more than thirty-five millions of tons of Utah Copper overburden will have found lodgment upon the surface of Col. Wall's property.

POINTS IN HEARINGS.

At the conclusion of a recent case, the Court, in summing up the evidence, replying to the charge of counsel for Wall that the sole purpose in constructing the lines, as was being done, was to dispose of Utah overburden, said: "Now, while the court may join with you in the suspicion that it (the road) is outlined in the way it is for the purpose of being able to use the waste, yet the court is unable to say that it is not necessary to outline it that way in order to have a proper road up there."

From all of the testimony elicited at the various hearings, it was clearly manifest that, when the ground shall have been filled with all of the Utah Copper overburden it will hold, there will be no further use for any of the lines above the lower branch of the lines shown in the picture above the tunnel.

The Court, in order to prepare himself to do full justice, before the hearing in one of the several cases, visited the ground and personally examined the method of construction of the several lines. And it was doubtless this examination that gave him the "suspicion" that the lines were being constructed in such manner as to provide storage for waste; but Engineer Goodrich, and Assistant Manager Gemmel had said the purpose was to use the SMALLEST POSSIBLE AMOUNT of waste in order to damage Wall's property as little as possible. In fact, it appears that these gentlemen had been lying awake o'nights

in order to devise the most gentle method whereby the excessive overburden of the Utah mines could be transferred to Col. Wall's property and at the same time not cause him any damage or discomfort. In their struggles, at least one very, very brilliant, and really humane scheme had been incubated, but the Court promptly declined to hear about it on grounds of "irrelevancy and immateriality;" but in justice to the benign intentions of these gentlemen, we think it should be given publicity:

LETTING WALL DOWN EASY.

In order to let Col. Wall down easy, it was decided to prove by expert testimony that Wall's property contained no ore of commercial value, and therefore he could not be damaged by covering the surface and closing his tunnels with waste. In fact, it would be a real kindness to Col. Wall if in this way they could cause him to abandon the property and thereby involuntarily conserve his strength and means. To this end, after a thorough examination and sampling of the underground workings (consisting of some 5000 feet of drifts and tunnels) by a crew of Utah mine engineers, which was quietly done between the hours of one and five o'clock in the morning—when Wall's men were not at work—Professors W. A. Wilson and Lafayette Burton were engaged to carefully and thoroughly examine, sample, and DETERMINE THE LACK of metallic value of all that part of the surface which had not theretofore been covered with waste. There is little doubt that these experts, had they been permitted to testify, would have established the fact that the ground not only contained no ore, but that Wall would be greatly benefitted by being forcibly prohibited from spending his money in any further search therefor in or upon the ground. But as before stated, the Court refused to hear the testimony, evidently much to the disappointment of Burton and Wilson, who appeared impatient to perform their part of the engagement. Mr. Shulder, of counsel for the Utah Company, took occasion, however, to declare "that the development of vast bodies of valuable ore by the Utah company upon adjoining ground had vastly more than compensated Wall for any inconvenience or damage which could result from dumping of any quantity of waste upon his ground," the inference being that Col. Wall ought to be required to pay the Utah company liberally for the benefits he would derive from knowledge of the existence of those vast bodies of valuable ore upon adjacent grounds, and that he should, in addition, cheerfully acquiesce in the Utah's method of disposing of its waste. After the explanation of Mr. Shulder, the Court rendered an opinion entirely in accord therewith. But, whether Col. Wall will accept the good intentions of his adversaries, as indicated by their engineers and counsel, in full satisfaction of his supposed grievances, we are at present unadvised.

WALL GROUND VALUABLE.

In respect to the ore-bearing character of the ground, Col. Wall testified at one of the hearings that the tunnel shown in the picture extends into the mountain about 300 feet; that the last ninety feet of its length is in ore of excellent commercial grade; that drifts extend longitudinally in similar ore eighty feet in each direction, and that an upraise has been made eighty-five feet and to within twenty feet of the surface, all in equally good ore. In fact, we are reliably informed that much of this contains from 3 to 7% copper, and that these facts are well known to the Utah company whose engineers have made frequent examinations and sampling tests of the ore during the absence of Wall's workmen. These developments lie parallel to and within about 150 feet of the Utah line, and it is believed that Utah underground mining has long since been extended over the line, into Wall's ground, and to within less than fifty feet from the face of the tunnel. This belief finds confirmation in the fact that a section of the surface about 150x100 feet, within a few feet from the face of the tunnel, and immediately above, was found to have become crushed and sunken several feet below the surrounding surface, precisely as the surface of the adjoining ground had sunken from underground "piracy" before it was bought by the Utah company from Barnsdall. It will be remembered that—as stated in this journal at the time—a little over a year ago that property (the Pay Roll group) was bought by Mr. Hastings for the Utah company for about $75,000 in cash, and that later, on our exposure of the pilfering of this ground by the Utah company to the extent of nearly $500,000 in value, Mr. Barnsdall secured restitution to the extent of 6,666 shares of Utah Copper stock.

It now seems quite certain that those same underground workings have been extended into Col. Wall's ground, which adjoins the Pay Roll ground on the north, the boundary line being shown in the picture near the top. The cave-in of the ground was first discovered by Frank Anderson, a mining and civil engineer, whilst engaged in locating the tracks and grades of the Bingham & Garfield Railroad Company, with relation to the boundaries of Col. Wall's ground. But, not thinking it expedient to expose the fact at the time, Col. Wall suggested to Mr. Anderson that possibly the cave might have been caused by means other than encroachments of the Utah company's underground workings and advised that no mention be made of the matter. Suspicion of the invasion of Wall's ground by the Utah underground miners was intensified by the feverish haste with which Chief Engineer Goodrich had sought to close the approach to the tunnel and thus prevent further progress of development in the direction of this caved section.

TO STOP WALL'S WORK.

It appears that about two months ago, when the railroad track shown in the picture as crossing the ground just above the tunnel entrance had been laid to the middle of the gulch and about 200 feet to the right of the tunnel, Mr. Goodrich notified Col. Wall that he had received instructions to fill in the gulch below the tunnel with waste overburden from Utah Copper ground, and that in doing so would necessarily cover the entrance to the tunnel, whereupon Col. Wall procured from the court a temporary injunction restraining the Bingham & Garfield Railroad Company from carrying into effect its avowed purpose. Whilst the injunction order was in full force Engineer Goodrich caused a train of cars loaded with Utah waste to be brought on the track and halted opposite the entrance to the tunnel so as to dump every car of the train directly over the entrance to the tunnel and in this manner effectually closed the approach thereto. But at the hearing of the case the fact appeared upon the testimony of Mr. Goodrich that the track—which had been previously laid, and which was on solid ground—was only temporary and that his ultimate design involved the complete filling in of all the low ground, which was being used for tunnel dump, down to the next railroad track below, and that when complete the track would be down to a straight line, so that in its extension to the right it would strike only the high point on the next ridge. This explanation was accepted by the Court as entirely satisfactory, and the restraining order was thereupon vacated.

Having secured the sanction of the Court to the closing up of Wall's tunnel, and thus shut off the possibility of its further extension in that direction, and exposure of the "caved section," all further work of extending "the much needed road" to the New Haven mine ceased, the object of the fill having been accomplished.

INJUNCTION VIOLATED.

Now it appears that this particular railroad track, with its two branches to the left, was laid upon ground not covered by the Court's original grant of possession, and therefore, a week or two later, another action was commenced by

Wall whereby he sought to prevent its further extension, as well as the use of that portion theretofore constructed. And thereupon an injunction was granted accordingly. By reason of certain contractural rights covering that portion of the property upon which these tracks had been laid, it seemed inevitable that this injunction must become permanent, and that the plan of the Utah company, by means of these "temporary" lines to dam up the gulches and thus provide storage room for waste, would thereby be defeated. It was therefore determined that, at all hazzards, the job of effectually rendering it impossible for Wall to reopen his tunnel or to run a new one in the region of the "cave-in"—for want of dump room—should be made complete.

To this end, in open and flagrant disregard of the Court's injunction, train service on that line was pressed to the limit, and with all possible speed waste from the Utah stripping benches was rushed over the road and dumped into the gulch shown in the picture below and adjacent to the tunnel, until every available foot of space between the line of the track shown above and the first track shown below the tunnel was filled, the upper track being shifted out on a level as the fill proceeded, so that on completion of the fill, that track occupied—and still occupies—a position from eighty to a hundred and sixty feet nearer the next track below than the position shown in the picture, the deepest portion of fill being probably seventy feet, and the breadth at the surface about 200 feet, and covers the tracks at the entrance to Wall's tunnel to the depth of about fifteen feet. There was consumed in completing the fill approximately 85,000 cubic yards of overburden, resulting in a saving to the Utah Copper Company, as compared to the actual cost of transporting the same to its nearest other available dumping ground, of at least eighteen cents per cubic yard, or a total of about $15,000, besides effectually shutting Colonel Wall out from any approach to that portion of his mines, or any means of espionage upon any encroachment of his more enterprising neighbors upon his orebodies, as was so successfully accomplished in the case of the Barnsdall-Pay Roll claims.

Upon a preliminary hearing in this latter case, the Court—as had been confidently anticipated—rendered a decision in which he ordered that a permanent injunction be issued. A few days later, however, he signed an order which practically, though doubtless unintentionally, vacated his previous order. By this action it is made to appear that the Court shares in the general sentiment which has been fostered by the management of the Utah company, viz., "that Col. Wall's fights against the progressive methods of that company are prompted solely by spite." Whatever may be the future outcome of these controversies—from a glance at the photograph—it is quite evident that Col. Wall will now be compelled to quit unless another branch of this tentacular railroad should be projected across that remaining three-quarters of an acre of his mining property which, as before stated, is shared by the Yampa people; in which event, good faith would seem to require that he should at least interpose a perfunctory defense in respect of the rights of his co-tenants.

COPPERETTES

"I would buy Chino stock. It certainly is entitled to sell up to $35 or $40 a share.—GEORGE L. WALKER." In Walker's Weekly Copper Letter, (Copyright by Dukelow & Walker), etc.

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Goodwin's Weekly: Through the dumping of waste the Utah Copper, of necessity, extends its railroad tracks. Every gully, gulch and draw in Carr fork and main Bingham canyon is being filled in with the overburden from the property. Consequently, the tracks are being extended to the shafts and tunnels of nearly every property in Bingham and within a few years the ore hauling situation in the camp will be controlled by the new railroad.

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Pain, Weber & Co.'s market letter of the 21st says: "The buying of the coppers was RATHER impressive and in that connection our London friends say they are of the opinion that the copper metal will sell higher." It will be noted that "our London friends" are being treated with a great deal of deference these days. Somebody is preparing to "put one over on them," sure.

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Referring to the deal through which it is claimed there will be a merger of the Miami, Live Oak and Inspiration properties in Arizona, the Salt Lake Tribune of December 7 says: "It looks to the disinterested western eye that there is to be a closer relation hereafter between the big copper producers, and that all possible cut-throat rivalry will be eliminated from the industry. It is now a case of everyone pulling together for the mutual good of all interested in the copper producing industry."

Let's see; if we remember correctly it is less than three years ago that the American Smelting-Utah Copper-Guggenheim interests were doing no small amount of boasting about "the survival of the fittest." It looks different now. As Jonah failed to swallow the whale, maybe the whale is figuring that it is time for him to get busy and show Jonah a trick or two.

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Last month it was stated in this department that Utah Copper had reopened a "construction" account on October 1. Two weeks ago we were advised that the company had begun the rigging up of two more units of its Arthur mill. With this heavy (?) and costly (?) piece of work under way, real justification for the sale of say 50,000 more shares of treasury stock at $50 ($2,500,0000) ought easily to be shown in the next annual report. Now that the price of copper has been advanced so materially the share market has broadened and the company ought to have seized the opportunity thus afforded to "get the money." Wonder if the forthcoming annual report will show that it did? If so, it will not much matter for some time to come what the real cost of stripping and mining has been; net earnings and surplus can be made to loom up bigger than ever.

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Salt Lake Tribune, Dec. 22: "Do you know that the Arthur mill of the Utah Copper company is doing by 10 per cent the finest work of any concentrating plant in the entire world?" asked an engineer who recently had the opportunity to convince himself of the kind of work being done there. He stated further that the Arthur plant is making copper for 7 cents a pound, and that six sections have been remodeled, the seventh is being worked on now, and all thirteen sections are to receive the same treatment shortly. It will not be long until the Magna mill is brought up to a like point of efficiency, although the Magna is making a magnificent record as it is now constituted.

It is certainly refreshing to learn that the Arthur plant "is making copper for 7 cents a pound" and that "it will not be long till the Magna plant is brought up to a like point of efficiency," because we have always been under the impression that copper was not made in either of these plants. The declaration that the Arthur mill "is doing by 10 per cent the finest work of any concentrating plant in the entire world" would sound better if some figures were given to illustrate the claim. The declaration also would have had more intrinsic value had the engineer's name been given.

UNSOLVED PROBLEMS OF GEOLOGY

SECOND PRESENTATION OF ORIGINAL AND INSTRUCTIVE DISCUSSION OF COMPLEX SUBJECT

By HIRAM W. HIXON.*

All the standard works on geology leave no doubt in the reader's mind that there have been no satisfactory explanations offered for many of the most common of geological phenomena. The following is a list of the most common of these effects for which a competent and satisfactory cause has long been sought:

(1) The normal fault, in which the opposite sides of the fracture have been spread apart and usually one side raised above its original position. This effect cannot be due to contraction or a settling down of crust blocks as that would produce an overthrust, or what is commonly called a reverse or thrust fault, because of the arching of the earth's crust.

(2) Earthquakes—Earth tremors or quakes are most common in regions of elevation, which is incompatible with their being produced by fracture and subsidence, in the manner generally ascribed. Further, the faults which are made at the time of great earthquakes are normal faults, which cannot be produced in an arching crust by subsidence.

(3) Volcanic action—This cannot be explained unless we can account for the local accumulation of heat beneath the volcanic vent accompanied by a large amount of steam saturating fused lava.

(4) Any explanation of volcanic action that does not include fissure eruptions will be incomplete.

(5) The observed order in which the lavas have been erupted, beginning with the acid lavas and ending with the basaltic lavas must also be accounted for.

(6) The formation of fissures of large and small extent wherein the crust is torn apart and the walls do not go back into contact, leaving long openings which are subsequently filled with mineral matter deposited from solution or by fused matter injected as a dike at the time the fissure was formed.

(7) The ascensive or elevating force which injects the dike matter into the fissure.

(8) The source of the heat and the water of hot springs and geysers. Such springs and geysers contain so much mineral matter in solution in their waters that they build up cones of deposition at the surface, from which it is apparent that the same solutions deposit mineral matter along the path of ascent and isolate by cementation their paths from all connection with surface waters. Water has about five times the specific heat of rock, so that five times the weight of rock would be required to furnish the heat units in the discharged water, if the rock were cooled through the same range of temperature as the water is heated. Applying this rule to the discharged water from Old Faithful or any other hot spring brings out the fact that the waters could not come into contact with or extract the heat by conduction from the adjacent rock for any great length of time. The cementation of the walls of the pipe would prevent circulation.

(9) Metamorphism, regional and local, in which the rise of temperature and the influx of highly heated waters have resulted in changing the bottom members of the sedimentary series from shales to mica schist, from sandstone to quartzite, gneiss and granite, and from limestone to marble.

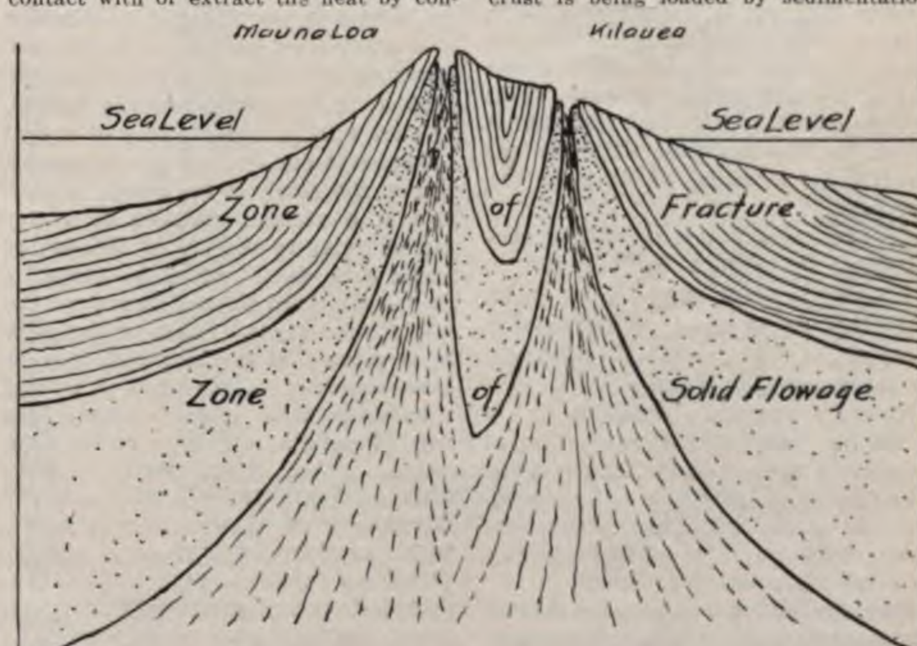
(10) The accumulation of natural gas and oil beneath impervious coverings such as shale; salt water usually being found below the oil and all occupying the arches of anticlines.

(11) The cause of elevation and subsidence, both continental and local.

PHYSICS OF THE EARTH'S CRUST.

The earth's crust, considered as a dome of 4000 miles radius, is incapable of supporting one five-hundredth part of its weight, even if thirty miles thick and composed of the material of the strength of granite.* This makes the crust a floating shell supported by the material beneath it and differences in elevation between continents and ocean bottoms are due to differences or density in the sub-crust material.

It is well known that wherever the crust is being loaded by sedimentation,



Intersecting Zones of Influence of Mauna Loa and Kilauea at Great Depth in Zone of Solid Flowage.

as at the mouths of rivers or on coasts where sand is being deposited by the ocean currents, as is occurring along the eastern coast of the United States, that subsidence is general. It is also generally true that a region of erosion is a region of elevation, but if this part of the crust continued forever to be a region of elevation, then it would follow that continental areas would lose all their sedimentary rocks and would present to view only igneous rocks. It would also follow that if a region of deposition was forever a region of subsidence and that a region of erosion was always one of elevation, the earth would

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*Le Conte, Chamberlin and Salisbury.

turn itself inside out. It is, therefore, apparent that the forces which govern these movements are subject to reversal after reaching a maximum in either direction. If the differences in elevation are due to differences in density of the sub-crust material as above stated, then how can these densities be reversed?

The answer to this problem includes the answer to all the others before enumerated, and in fact the operating cause can be shown according to the following theory of the earth's physics to be common to all the effects produced, and to include, in addition to those already mentioned, ore deposits, mountain folding and elevation, the deposition of graphite in gneiss and in mineral veins, and the formation of diamonds in volcanic necks.

Since the introduction of the electric furnace into metallurgical operations, it has been found that all known elements can be volatilized at a temperature estimated to be below 3700° C. (6692° F.) Carbon, the most refractory of all substances by itself in a pure state, is easily attacked by hydrogen and converted into one of the most volatile of gases (CH_4) at comparatively low temperatures, as shown in the formation of water gas and the decomposition of steam by red-hot coke.

In like manner the volatilizing temperature, the critical temperature and the fusing point of all the mixed materials that go to make up the interior mass of the earth is probably influenced by the presence of steam.

The first requisite condition is to prove the presence of steam and other light gases throughout the interior mass. The method of doing this is by the application of the law of critical temperature and the law of the diffusion of gases to a gaseous planet.

Farraday and others discovered that for each gas there is a critical temperature above which it cannot be liquified by any pressure, however great. SINCE ALL SUBSTANCES CAN BE GASIFIED IN THE ELECTRIC FURNACE, IT FOLLOWS THAT AT SOME HIGHER TEMPERATURE THEY WILL BE PERMANENT GASES REGARDLESS OF ANY PRESSURE THAT THEY MAY BE SUBJECT TO.

Astronomers are generally agreed that all the matter in the sun is permanently gaseous, regardless of pressure, for the reason that it is above its critical temperature. There is every reason for believing that the earth has passed through the same critical tempeature stage as the sun is now in, regardless of the condition or mode of accumulation of the material that entered into its composition. It is not necessary to postulate a temperature higher than physicists are willing to admit in order to have matter in the zone of critical temperature in a gaseous state; neither is it necessary to insist on any particular temperature gradient from the surface downward in order to arrive at a critical temperature at some depth. It is immaterial if that zone of critical temperature be reached at 100 miles of depth or 1000 miles. When it is reached all the matter in that zone will be gaseous AND NECESSARILY DENSER THAN THE SOLID forms of matter above it because of the pressure. IF IT WERE LIGHTER THAN THE SOLID FORMS OF MATTER IT WOULD NOT REMAIN AT THE BOTTOM, BUT WOULD GET ON TOP. We have thus a means of knowing that gaseous matter above its critical temperature can be compressed to a greater density than a solid.*

Whether we start with a gaseous planet above its critical temperature and go forward to the present condition of a cold crust lying on top of a solid viscuous zone of material of increasing temperature until it finally becomes gaseous, or start with the present zone of critical temperature and go back to the gaseous planet, the result is the same. We arrive at a gaseous condition of matter where, owing to the law of diffusion of gases, each gas of which the planet is or was composed diffused throughout the whole body of gas. The essential point is to prove that in the mixed body of gaseous matter in the zone of critical temperature there is every kind of gas that entered itno the composition of the gaseous planet. THIS WOULD FOLLOW AS A RESULT OF THE LAW OF DIFFUSION OF GASES WHICH IS TO THE EFFECT THAT IN A MIXED BODY OF GASES EACH GAS DIFFUSES THROUGHOUT THE ENTIRE MASS REGARDLESS OF DENSITY.

Starting with this zone of critical temperature of gaseous matter denser than the solid forms and containing some of each of the gases that existed in the original gaseous planet, it is possible to outline some of the effects that will follow upon secular cooling.

EFFECTS FOLLOWING SECULAR COOLING.

Knowing as we do that the gaseous matter in the zone of critical temperature must be denser than the solid in order for it to remain below the solid, we can see that as it loses heat a portion of the gases of high critical temperature will pass from the gaseous to the next lighter condition of matter, WHICH WILL BE THE SOLID IN PREFERENCE TO THE LIQUID, BECAUSE IT WOULD HAVE TO EXPAND LESS AGAINST THE HIGH PRESSURE IN ORDER TO DO SO.

The passing of a gas denser than a solid into a solid condition of matter without becoming liquid is in line with the observed facts that an increase of pressure increases the melting temperature of all matter that expands on fusing. SUFFICIENT PRESSURE MAY INCREASE THE MELTING TEMPERATURE TO SUCH AN EXTENT THAT THE MELTING POINT AND THE CRITICAL TEMPERATURE ARE THE SAME. Liquid or melted matter is only supposed to exist in the peaks and ridges in the top of the zone of solid flowage where it is supersaturated to the highest degree by steam.

The gases of low critical temperature, which have been associated with this material while it is gaseous, can no longer remain with it under the same conditions since it has become a solid, and they therefore supersaturate the zone of critical temperature and the solid matter above it, which we have called the zone of solid flowage, and diffuses upward until it reaches the bottom of the zone of fracture. AS LONG AS THESE GASES OF LOW CRITICAL TEMPERATURE ARE IN THE ZONE OF CRITICAL TEMPERATURE THEY ARE HELD THERE BY THE SAME POWER OF DIFFUSION WHICH PUT THEM THERE ORIGINALLY. But when by the loss of heat the gases of high critical temperature are changed into solids, there comes into action a force which for want of a descriptive name, I have called "DIFFERENTIAL PRESSURE," THE DIFFERENCE BETWEEN THE WEIGHT OF A COLUMN OF THE HEAVY MATERIAL FROM THE SURFACE OF THE EARTH DOWN TO ANY PARTICULAR DEPTH, AND THE WEIGHT OF A COLUMN OF THE GASES OF LOW CRITICAL TEMPERATURE UNDER THE SAME PRESSURE AND TEMPERATURE TO THE SAME DEPTH.

I have estimated this at 27 tons per square inch for a depth of ten miles, or 270 tons per square inch at 100 miles of depth, and increasing rapidly with depth.

This is the force which drives the gases of low critical temperature up through the zone of solid flowage in which fractures are impossible and causes it to collect below the zone of fracture under constantly increasing temperature and pressure, like water collecting above a dam. The gases of low critical temperature supersaturate the whole mass of the zone of solid flowage and a bubble of gas above the point of

*The term "gas" does not refer to density, but to a definite amount of latent energy, just as does the liquid condition of matter.

saturation cannot disappear at one point without appearing at a higher level, so that the bubbles, although disconnected, are forced upward by the unbalanced force the difference between the weight of a column of the zone of solid flowage and a column of the gases under the same temperature and pressure to the depth where the particular bubble is located.

In this manner the gases of low critical temperature cannot escape from the zone of critical temperature faster than they are liberated by secular cooling, and this governs their passage through the zone of solid flowage and their accumulation below the zone of fracture. The passage of these gases through the zone of fracture is much slower than through the viscuous solid material of high temperature in the zone of solid flowage and the result is that THE UPPER PORTION OF THE ZONE OF SOLID FLOWAGE IS MORE HIGHLY SUPERSATURATED THAN ANY OTHER PORTION. The accumulation of these gases of low critical temperature (which are principally steam) results in elevating the temperature beneath the cold crust or zone of fracture and brings about the regional metamorphism of the bottom beds of the sedimentary series and produce conditions FAVORABLE FOR INFILTRATION OF SILICA AND THE FORMATION OF FELDSPAR AND MICA WHICH CANNOT BE FORMED BY DRY FUSION.

The increase of temperature with depth varies between wide limits depending upon the volcanic activity in the place where the observation is taken. If the bore hole or shaft happens to cross an inclined fault plane which acts as a vent for heated waters, the temperature may even decrease after passing below the intersection, which would give rise to the belief that has been advanced that the earth gets colder with depth instead of hotter, but the evidence of high internal temperature is unmistakable and the local variations are of small consequence in the final consideration.

THE ACCUMULATION OF GASES BELOW THE ZONE OF FRACTURE IS ACCOMPANIED BY A REDUCTION OF DENSITY DUE TO THE EXPANSION OF THE GASES UNDER DECREASED PRESSURE AND THE GREATER VESICULARITY OF THE ROCKS RESULTS IN SUPERFICIAL ELEVATION. LE CONTE QUOTES SORBY AS STATING THAT GRANITE CONTAINS AS MANY AS ONE THOUSAND MILLION VESICLES PER CUBIC INCH.

EARTHQUAKE PHENOMENA.

The tendency is for the elevation to become more pronounced locally along the axis of the region and when the elastic pressure of the supersaturating steam in the top of the zone of solid flowage is sufficient to rip the zone of fracture, a fissure is formed, into which the steam rushes under the differential pressure which has been accumulating for geological ages and in an instant an earthquake follows. The walls of the fissure are cold enough to condense the steam and they close by reflex action resulting in a sudden blow to the region immediately above and around the fracture plane. The steam continues to open the fracture and be condensed with the accompanying noise and shocks until its elastic pressure is so diminished as to be unequal to the task when another period of accumulation must follow before a sufficient elastic pressure will be available for reopening the fissure.

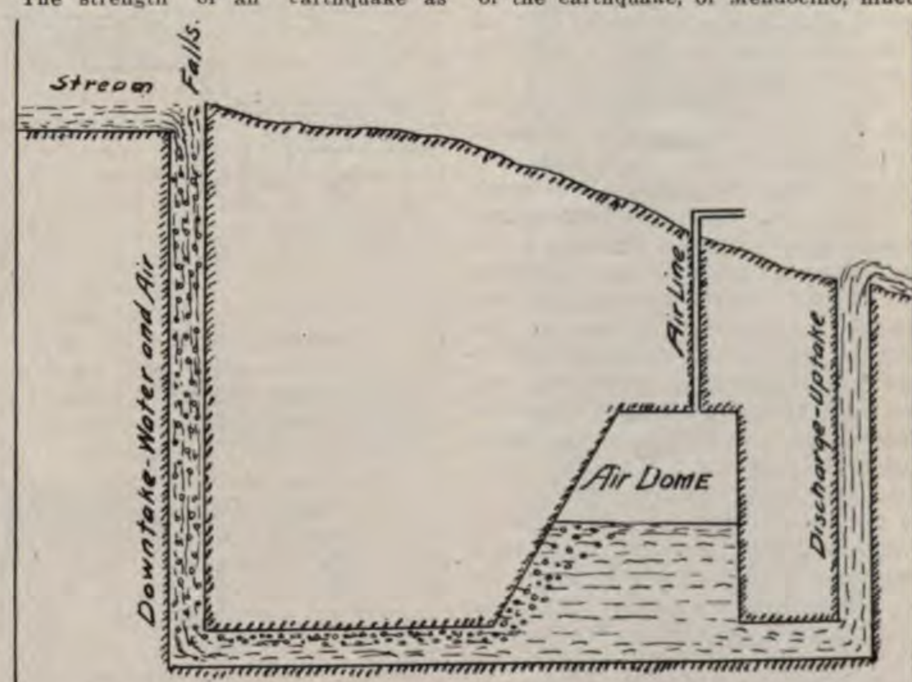
The strength of an earthquake as measured by the area of surface over which it is felt is proportionate to the depth at which the focus is located. Great earthquakes occur at depths of from 7 to 15 miles and at such depths rock matter is capable of movement under pressure without fracture so that fractures cannot be the cause of earthquakes occuring at that depth.

Steam above its critical temperature of 365° C. (689 F.) cannot condense to water so that shocks cannot be produced at depths where the temperature is 365° C. or above. Assuming 30° C. the surface and an increase of 1° C. per 100 ft. or 53° C. per mile, earthquakes due to condensation of steam as suggested should occur at about 7 miles of depth.

The main displacement in connection with the San Francisco earthquake was horizontal, but there was vertical displacement on both sides of the fault at different points. *"From the rift at times in the past, masses of molten rock have flowed out. Of such origin is the cliff of basaltic columns near San Francisquito creek on the Stanford university campus. Much more recent flows of black lava occur to the southwest of Stanford University and numerous dikes of lava occur for the whole length of Santa Clara valley; these have not flowed from volcanoes, but in times long past have escaped from rifts in the rocks—producing earthquakes. Some of the rifts have been cemented and closed by their own lava flows."

Steam probably escapes from the fault and condenses in the ocean as indicated by the following extract: "The steamer Argo crossing the fault line the moment of the earthquake, of Mendocino, ninety miles to the northward of Point Arena, bears witness to the fact. The captain thought that he had struck a raft of logs, so fierce and hard were the shocks of the waves in the water. The movements were short and violent not forming a tidal wave, but a strong choppy sea. At this point numerous earthquakes have been reported by passing vessels."

The following are probably due to the rapid opening and closing of the fault by intrusion and condensation of steam: "During the shock men, cows and horses found it impossible to stand and fell to the ground; and some persons were thrown from their beds. In a general way all these evidences of violence diminish gradually with distance from the fault on either side. The springs and streams on both sides of the Santa Cruz



Sketch Illustrating Hydraulic Air Compression, in which the Principle of Differential Pressure is Used, as Described in This Article.

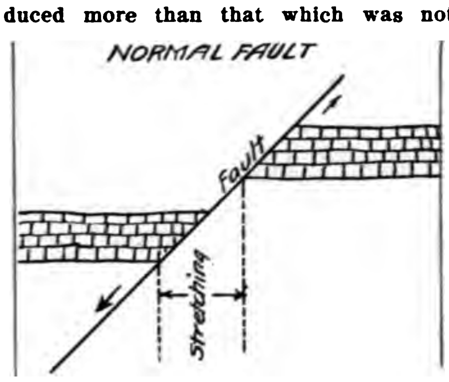
* California Earthquake, 1906; edited by David Starr Jordan.

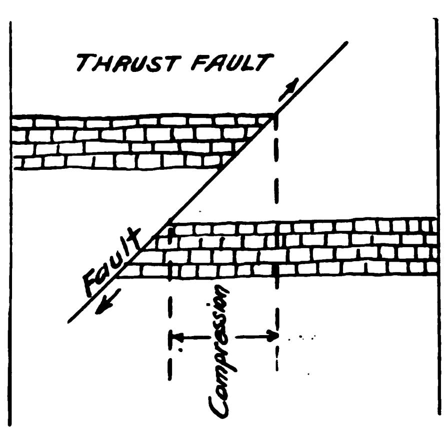
range south of San Francisco, increased in volume after the earthquake and some creeks on the west side were nearly doubled. All the streams were muddy for several days after the earthquake. A market effect was produced on the ARTESION BELT near the head of San Francisco bay. Wells that had previously been dry began flowing, and wells that flowed before the shock greatly increased in volume and pressure. A well near Alviso, at the head of the bay, formerly required a wind mill to pump the water. At the time of the earthquake the casing was driven 2 feet out of the ground, wrecking the pump, and since that time the well has been flowing under a heavy pressure." These flows of water appear to have been due to condensed steam as the temperature was raised, and the horizontal displacement due to the relief of earth strain while the walls of the fault were thrown apart by the steam.

When in the process of time and repetition the dike is advanced to the surface, the material blows out as lapeli, pumice or scorea and is usually highly silicious as it has been derived from a silicious magma long in process of making by the infiltration of silica into the rocks through which it has finally melted and fractured its way to the surface. Subsequent eruptions will be less and less silicious if derived from the same fissure until by the process of displacement and rise from great depth under the impelling force of the supersaturated steam, basaltic material is brought up to complete the cycle of eruptions which gradually come to a close because of the liberation of a great local accumulation of steam which has required much greater length of geological time for accumulation than for its escape. The fissure eruption differs from the crater eruption in quantity of material discharged and also in the lavas always being basaltic in character with a much greater fluidity and lower fusing point. They are supersaturated with steam in the same manner, which reduces their density to less than that of the overlying rocks and when a fissure is opened by tearing of the crust by the tension of the steam under the accumulated differential pressure, the lava continues to well up and discharge from the fissure until by the escape of the steam the density of the mass which has been left behind and in the fissure is equal to that above, and the eruption stops and another period of accumulation follows when the eruption is repeated from the same fissure or a new one formed.

FAULTS AND FISSURES.

The normal fault which as its name indicates is the most numerous type of faults, can be explained on the theory that after the rupture of the crust by the tensional pressure of the supersaturating steam in the peaks or ridges in the top of the zone of solid flowage, one of the regions on either side of the fault has had the density reduced more than the other and after the rupture that side of the fault remains permanently higher than the other. In the case of the Sonora earthquake of 1886, there was a vertical displacement of several feet on each side of a range of mountains, the mountains being elevated en block, which would indicate that the density beneath the region elvated was reduced more than that which was not





elevated and the strain on the crust caused it to snap or tear at the fault planes.

Fault planes are places where the inelastic crust adjusts itself to changed conditions in the zone of solid flowage which have been a long time in developing. They are also lines of least resistance for the passage of the excess of elastic matter to the surface and are therfore occupied by dikes or by matter deposited from solution, by replacement of the walls if they happen to be of a soluble nature, or by mineral matter deposited from solution by reduction of temperature and pressure. The elevating force is the same elastic pressure of the gases of low critical temperature which have accumulated under the differential pressure corresponding to a much greater depth than where they may have caused the rupture.

This differential pressure has now a practical application in compressing air at waterfalls, two of which are in operation, one on the Montreal river near Cobalt, Ont., and the other in Northern Michigan or Minnesota.

Shafts are sunk above and below the falls to a depth corresponding to the air pressure desired. Those shafts are then connected with a horizontal tunnel at their bottoms and a dome chamber is cut out in the roof of the tunnel from which a pipe (with the end opening into the top of the dome) leads to the surface to take off the air that separates from the water in the dome. If air at 130 lb. per square inch is required then the shaft above the falls must be about 350 feet deep if the falls are 20 ft. high, which will make the shaft below the falls 330 ft. deep. The water will rise into the dome probably 10 ft., which will make the air under a differential pressure of 320 ft. and deducting 20 ft. for loss of head due to friction, etc., the air will be delivered at the surface under a pressure of 300 ft. of water which at 0.44 lb. per foot will give 132 lb. per square inch.

Air is admitted with the falling water into the shaft above the falls and carried down by it to the dome in the tunnel, where it separates and comes up the air pipe while the water rises up the discharge shaft into the river below the falls. The air pressure depends entirely upon the depth of the shafts and not upon the height of the water falls.

The pressure of the air is governed by the depth of the point of separation between the air and the water in the dome in the tunnel connecting the bottoms of the shafts and is the difference between the weight of a column of water from the surface of the discharge down to the surface of the water in the air dome, and the weight of the air through the same depth. The water is supersaturated with air and only the air above the point of saturation in the dome is available for discharge as compressed air, the air dissolved in the water escapes with it into the river. The principle involved is exactly the same as in the case of the gases of low critical temperature supersaturating the material in the zone of solid flowage.

The fact that the material in the zone of solid flowage is solid and not liquid, makes no difference because at the temperature and pressure in that zone the solid matter behaves like a thick viscous liquid or like ice in a glacier, which is solid but still able to move and readjust itself to changes of pressure or distorting influences, allowing contraction to take place throughout the interior and only locally in the crust as it does in mountain ranges. The zone

of greatest supersaturation is probably the line of slip between the zone of fracture and the zone of solid flowage.

If the gasses of low critical temperature accumulate beneath the cold crust or zone of fracture more rapidly than they escape through it to the surface, then the density of the highest point in that zone will be reduced most rapidly and result in regional and local elevation. JUST AS THE SURFACE OF A LOAF OF BREAD RISES FROM THE ACCUMULATION AND EXPANSION OF GASES IN THE DOUGH. At the same time the differential pressure of the gas will increase to correspond to greater depths of separation and may

Section of Steel Ingot (Unhammered) With Little Bubbles of Gas Traveling Upward and Expanding Beneath The Crust.

acquire a pressure of several hundred tons per square inch if not relieved by the opening of a fissure or a volcanic explosion or by the passage to the surface through the capillary pores of the igneous rocks when not covered by impervious sediments.

If, on the other hand, fissures are opened giving rise to earthquakes, hot springs and volcanic explosions, or if erosion carries away the impervious covering of sedimentary rocks so that the gases escape to the surface faster than they accumulate beneath the zone of fracture then the regional density will increase and the surface will subside.

MOUNTAINOUS FORMATIONS.

It follows from the above reasoning that where there are no volcanoes and the accumulation of gas below the zone of fracture is slowest in making its escape to the surface that the greatest elevations will be found. The Himalaya mountains and plateau of Tibet seem to corroborate this theory. The effect of a small difference in density is much greater on a thick zone of solid flowage than on a thin one and as a result the difference of elevation may be growing larger as the zone grows thicker.

Another phenomena which these great fluctuations of elevation may account for is the glacial periods which have occurred in past geoligcal ages. Certainly elevation brings about refrigeration of climate and places near the equator may have been given such a climate by elevation.

The generally accepted theory of mountain formation is that the beds are compressed and thickened by lateral thrust which results in local elevation and folding along the axis of the folds. If this were the cause of elevation it would be contrary to the generally observed fact that loading the crust produces subsidence.

THICKENING THE FOLDS LOCALLY BY COMPRESSION WOULD INCREASE THE LOAD LOCALLY AND AS BEFORE STATED, THE CRUST IS INCAPABLE OF SUPPORTING THE 1-500 PART OF ITS OWN WEIGHT, SO THAT, WHATEVER THE CAUSE OF ELEVATION, IT IS A FORCE ACTING IN THE SUBCRUST MATERIAL, AND AS THAT IS CAPABLE OF MOVEMENT UNDER A DISTORTING PRESSURE, THE CAUSE OF ELEVATION MUST BE A REDUCTION OF DENSITY. The effect of an accumulation of a large amount of steam and other gasses locally would be to SOFTEN THE SUBCRUST MATERIAL, ELEVATE THE ISOGEOTHERMS, REDUCE THE DENSITY AND PROMOTE FOLDING FROM THE EFFECT OF THE LATERAL DRAG ON THE BOTTOM OF THE COLD CRUST BY SHOVING IN OF MATERIAL OF REDUCED DENSITY BENEATH THE ELEVATED REGION.

The effect of this bottom drag on the zone of fracture WOULD BE TO STRETCH REGIONS ON BOTH SIDES OF MOUNTAIN RANGES AND CRUMPLE OR FOLD THE ZONE OF FRACTURE WHERE THE OPPOSING SHEETS OF THAT ZONE MEET. Normal faults would be produced in all places of stretch and thrust faults in regions of fold. The incompetence of simple contraction, as shown by Osmond Fisher to account for the reduction of the circumference of the earth to the extent shown in mountain folding indicates that the folding and elevation must be due to some other cause which produces folds in some parts and extensions in others. It seems probable that volcanic action may follow along the rifts produced by extension as well as by folding.

The planitesimal hypothesis proposed by Prof. T. C. Chamberlin, appears to be open to three serious objections.

First. If the earth was built up slowly of cold planetesimals and the heat at the surface was never sufficient to fuse or gasify the material after it reached the earth—then it would follow that the water on the surface would stratify that planetesimal material into a

Hammered Steel Ingot, Showing How the Gas Bubbles Cause Little Volcanoes to Erupt Liquid Steel Until the Crust is Solidified.

series of rocks which should everywhere show as the archean stratified beds and be easily identified. The planetesimals which fall at present are probably representative of what fell in the past, and these are largely composed of nickel iron which resists oxidation and should be found among the material composing the archean sediments. The fact that no such beds are known indicates that they never existed.

Second. The moon with only 1-81 the mass of the earth shows unmistakable evidence of volcanic action, if we regard the craters as such, or of heat sufficient to fuse at the surface if we regard the

craters as due to impact, and it seems highly improbable that the earth with so much greater mass should be cold at the surface as postulated by the planetesimal hypothesis.

Third. Heat is not produced by pressure acting on a cold incompressable aggregation of matter such as the planetesimal hypothesis indicates that the earth was built up of. In order to produce heat weight must act through distance which would make it necessary that the cold material be compressable.

Fourth. If the heat has been developed in recent geological times by pressure, then expansion of the earth should have taken place instead of contraction and folding of which there is so much in evidence in mountain ranges.

The computed temperatures according to the planetesimal hypothesis as given on page 564 of Vol. 1, Chamberlin and Salisbury Geology, are higher than seems necessary to pass the critical temperature of all matter, at a depth of one-quarter of the earth's radius, or approximately 1,000 miles. This would mean that the interior is in a gaseous condition regardless of density.

All objections to a gaseous interior based on lack of rigidity disregard the fact THAT ALL MATERIAL KNOWN LOSES RIGIDITY AT SUCH HIGH TEMPERATURES AS CHAMBERLIN INDICATES AND IN FACT AT VERY MUCH LOWER TEMPERATURES RIGIDITY IS ENTIRELY LOST. PRESSURE MUST THEREFORE BE THE MAIN CAUSE OF RIGIDITY OF THE EARTH'S INTERIOR.

As corroborative evidence that elevation depends on density not only in mountain ranges but in continental areas, I will call attention to the work that the Indian government has had done on a series of tests with the second pendulum at various altitudes in the Himalaya region, by which it was found that the density of the earth at different points varies with the altitude*.

A similar transcontinental survey of the United States is mentioned by Le Conte, page 177, as giving similar results.

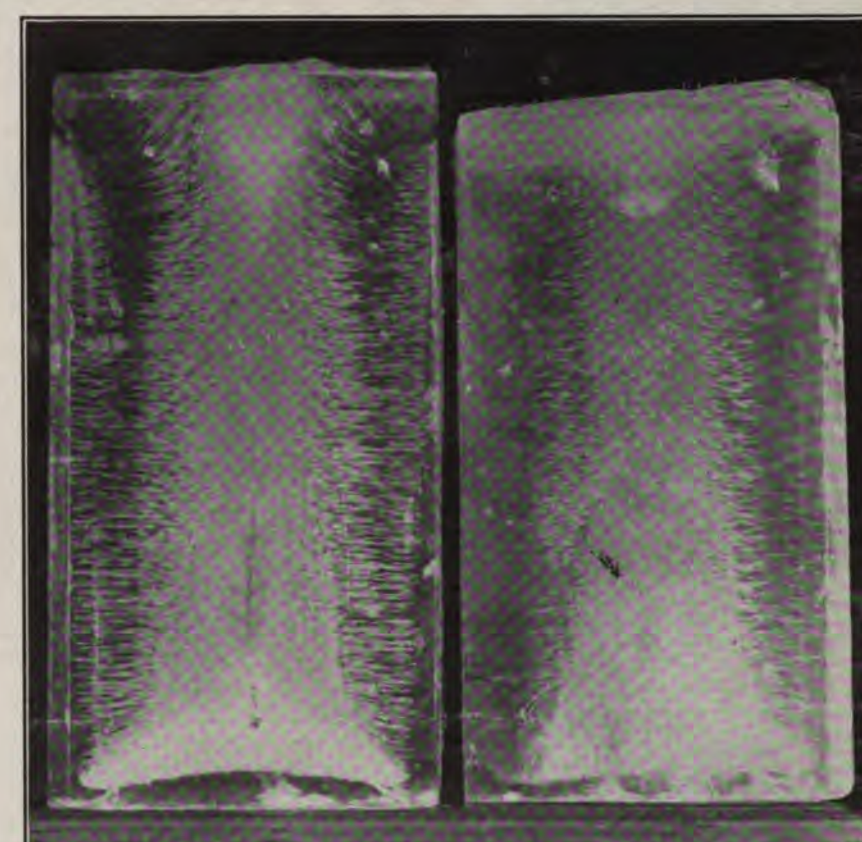
Followed to its logical conclusion, this theory of the cause of elevation and subsidence leads to the same result as stated in recent publications of the Investigation of the Coast and Geodetic Survey, viz., that the isostic layer of the earth's crust, if divided into equal areas bounded by vertical planes to a depth of 70 miles below sea level will contain equal amounts of matter, whether the area is above or below sea level.

From the money grubbing individual without imagination such theories bring forth the comment that there is no money to be made out of that, therefore what's the use? But here is the ultimate result which includes the non-imaginative individual and his money; if it were not for the existence of this force which renders some parts of the earth's crust less dense than others and causes them to stand higher, then the whole solid surface would stand at about the same level and the ocean would cool it all and render life, as we see and know it, impossible. It is certainly worth while to know of a cause so universal in its action.

Take the Grand Canyon of Arizona as an example. There is a geological record in its walls of subsidence followed by deposition of beds of Algon age—elevation and erosion followed by subsidence and deposition of several thousand feet thickness of sediments, and again elevation and erosion of probably 10,000 feet of beds only remnants of which can now be detected on the plateau through which the river has cut the canyon. Erosion is given as the cause of the canyon, but I submit that erosion is caused by elevation and as elevation is shown to be caused by reduction of density by expanding steam traveling towards the surface, then the ultimate cause of the Grand Canyon is due to some general cause, as elevation. As evidence that this is true: at a point known as Vulcan's Throne on the Toroweapa opposite Cataract Canyon, a crater has erupted lava which Powell reports as having filled the canyon nearly to the rim, remnants of the lava flood still adhering to the canyon walls on both sides and a rapid known as "lava falls" in the river shows that the canyon was deeper than now, at the time of the eruption.

The numerous subsidences of islands and land areas following volcanic eruptions and earthquakes point to an increase of density after liberation of or condensation of steam. The temple of Serapis near Naples as described by Le Conte, page 141, furnishes a classical example of repeated elevation during accumulation of steam, and subsidence following the volcanic explosion of Monte Nuova.

These rapid changes of elevation due to fluctuations in density are exceptional and the great continental changes take place by a much slower process wherein erosion of the impervious covering of sedimentary rocks is the means of providing the more rapid escape than accumulation. The slow increase of density results in a slow rate of subsidence unless the crust be rapidly loaded by sedimentation, as is the case in river deltas



Artificial Ice, Showing how Dissolved Gases are Crowded Toward Center of the Cakes as Freezing Takes Place from the Outside. This illustrates how the Zone of Fracture, Which is Solid Because it is Cold, Does Not Allow the Steam to Pass Through Like the Zone of Solid Flowage, Which is Solid from Pressure.

*Osmond Fisher, Physics of the Earth's Crust.

which are known to subside more rapidly than other parts. SUBSIDENCE AFTER VOLCANIC ACTION HAS CEASED IS INDICATED BY DESECTED CONES SHOWING THE STRATIFIED BEDS DIPPING TOWARD THE CENTER OF ACTIVITY, WHILE IN ACTIVE CONES JUST THE REVERSE IS TRUE. This indicates that after the escape of the elastic medium, steam, which is the motive force of volcanic action, that the density has increased and the surface has subsided.

SURFACES NOT PERMANENT.

It follows from a consideration of the above-mentioned conditions that the continents are not permanent and neither are the ocean basins. The logical conclusion therefore is that every part of the earth's surface whether covered by land or ocean has been above sea level at some time and at another time below.

This disposes of one of the greatest difficulties geologists have had to contend with, NAMELY, FROM WHENCE CAME THE MATERIALS TO MAKE THE THOUSANDS OF FEET IN THICKNESS OF THE SEDIMENTARY SERIES WHICH AT PRESENT COVER OUR CONTINENTAL AREAS?

"The hills are shadows and they flow
"From form to form, and nothing stands—
"They melt like mists. The solid lands
"Like clouds they shape themselves and go."

Suppose two adjoining regions to have a difference in density of say 2%.

Apply that difference through a thickness of 200 miles of crust and it will admit of a difference of elevation of four miles and still the two regions be in equilibrium without taking into account that the ocean water will cover the lower portions and admit of a still greater difference in elevation. There are doubtless much greater differences of density than 2%, but they are local and give rise to local elevations. When these densities get reversed by the more rapid discharge than accumulation of the leavening gases beneath the continents and the more rapid accumulation than discharge in the case of the sediment covered ocean bottom, then the ocean bottom will be elevated above and the continent depressed below sea level.

The thicker the covering of sedimentary rocks the more impervious will be the covering and the more certain is the region to be elevated in time. This explains why it is that the sedimentary series exposed in mountain ranges is thicker than in the level plains on either side and shows how it may not be due to compression.

The discharge of hot water through geysers or hot springs or volcanoes where the discharge is not rapid enough to be called an eruption is easily understood if both the water and the heat are derived from the interior zone of critical tempreature. They may deposit mineral matter in the fissures through which they ascend until they choke themselves, and it will result in the pressure accumulating until the walls of the fissure are spread apart again, A FACT THAT IS OBSERVED TO HAVE OCCURRED FREQUENTLY, AS SHOWN IN THE MINING OF ORES IN FISSURE VEINS.

The great accumulations of oil and natural gas can be explained on the basis of the gaseous interior containing hydrocarbon gases along with the steam and other gases or by the action of the ascending steam on metallic carbides contained in the zone of solid flowage.

The latter explanation is the more probable and is similar to the theory of Mendelljeff except as to the origin of the water. By this theory the great pressure of the oil and gas are residual from the differential pressure and the salt water below the oil is due to the condensation of the steam and the leaching of salt from igneous rocks.

The reservoirs are found below thick beds of shales which act as elastic coverings for non-elastic beds which are faulted by the pressure of the ascending gases, while the shale will stretch and not fault and acts as an impervious blanket for a non-elastic series below.

The deposition of graphite would follow upon the decomposition of some of the heavy hydrocarbon series in the same manner as coke is left behind in the cracking or distillation of oil and diamonds be deposited in volcanic necks in the presence of superheated water, carbonic acid and hydrocarbons.

Gardner Williams' description of the diamond mines of Kimberley (Smithsonian Institute, 1905) shows that the region within which the volcanic pipes are located has no exterior drainage, and has evidently subsided by increase of density since the volcanic action ceased. The material erupted was probably volcanic mud, easily eroded, which accounts for the ejected material being swept away. As conditions favorable for the formation of diamonds required high pressure, the portion swept away would not contain them and erosion would have to remove the upper portion of the pipe before they would be brought to the surface.

The objection has been offered that H_2S, CO_2 and the hydrocarbon series as represented by CN H_2N+_2 are unstable at high temperatures and could not come from a region of critical temperature. This is easily explained if we suppose the unstable gas to be the result of chemical reactions taking place near the surface, where the temperature is below their decomposing temperature. For example: $3CO+H_2O+SO_2=H_2S+3CO_2$ by which two unstable gases are made out of three that are stable at high temperature.

Metallic carbides would be formed by the action of carbon on the metals as soon as they condensed to solids and must form a considerable portion of the zone of solid flowage. Steam rising through these will produce acetylene, CH_2, which united in various proportions with CH_4, which make the whole paraffine series CnH_2n+_2.

From the fact that a short distance below the surface of the earth ores are generally sulphides, and from the presence of hydrogen in volcanic gas and the evidence offered by petroleum and natural gas, we can see that there is a deficit of oxygen below the surface and further that the oxygen in the atmosphere is the result of the decomposition of CO_2 by the vegetation which is now buried in the coal measures.

The formation of laccolites may be explained in much the same manner as the intrusion of dikes, with this difference that a laccolite requires an elastic covering above an inelastic base in the same manner as suggested for the accumulation of oil and natural gas.

The inelastic base is faulted by stretching and the dike matter intruded below the elastic shale which stretches and rises in a dome as the fluid mass collects beneath it. Laccolites are in most cases of silicious character because they represent the first efforts toward volcanic eruptions and are hydrous fusions of granite and other silicious rocks. Laccolites are much more favorable to the formation of ore bodies than lava flows because of the slower separation of the steam from the fused matter and the opportunity for local enrichment from magmatic solutions.

The standard objection to the theory of a gaseous interior is lack of rigidity to resis tidal action. This may be answered by the statement that rigidity is a property of matter acquired by reduction of the amplitude of vibration of its molecules with relation to each other.

For example heat a bar of iron and the amplitude of vibration of its molecule is increased and it loses rigidity; cool the bar of iron and the amplitude of vibration is reduced until it acquires rigidity.

The gaseous matter in the zone of critical temperature must be denser than the solid matter above it in order to retain its position; having greater density than the solid matter the amplitude of vibration of its molecules with relation to each other must be less, and it should therefore have greater rigidity.

LEACHING APPLIED TO COPPER ORE*

Thirteenth Article Reviewing Results Accomplished, With Special Reference to the Laszczynski Process and Its Adaptability to Small Leaching Operations.

By W. L. AUSTIN.†

On April 19th, 1904, there was issued to Stanislaw Laszczynski of Kielce, Russia, U. S. Patent No. 757,817, covering a "process of electrolytically extracting copper and zinc from ores." The essential feature of this patent is the use of insoluble anodes, tightly wrapped in thick cotton or other texture (flannel), in electrolyzing a sulphate lixivium. This texture constitutes a permeable envelope, the thickness of which must be in inverse proportion to the applied density of current, (as will be explained further down), and serves to prevent anodic oxidation of the cathions. It is stated on good authority that this process permits the economic removal of copper from solutions containing that metal, with the production of a superior quality of electrolytic copper, leaving the liquor in condition to be used for leaching a fresh batch of ore.

According to published statements, the method is in operation at two points in Russia, and it is claimed for it that it can be employed advantageously in small units, and that it does not require expensive supervision. One of the plants, that at Miedzianka in Russian Poland, has been described in "Oesterreichische Zeitschrift fuer Berg und Huettenwesen," 1906, page 387, and quite recently a serial article, reviewing the general aspects of the process, together with an account of its application at Kakaralinsk in Siberia, has appeared in "Revista Minera, Metalurgica y de Ingenieria," written by Walter Stoeger. The sequence in this latter article has been followed in the description of the process given below, amplified by notes derived from other sources.

The development of the process has been ascribed to the efforts of Dr. St. v. Laszczynski, who also is given credit for constructing the first plant, and directing its operation until the initial difficulties had been satisfactorily overcome.

APPLICATION OF PROCESS.

In carrying out the Laszczynski process the ore is first crushed by rolls, and if it happens to be a sulphide, it is then mixed with five per cent of damp loam (brick-earth), molded into blocks, dried, and roasted, with a view to getting a product containing copper-oxide and sulphate. The roasted ore is then again crushed fine before lixiviating with dilute sulphuric acid, whereby, (provided the roasting has been properly conducted), all the copper is said to go into solution in the form of sulphate. The lixivium is then subjected to electrolysis, using insoluble lead anodes and copper cathodes, and current is applied until no more than traces of copper remain in the electrolyte. While copper is being deposited at the cathode, a corresponding quantity of sulphuric anhydride is formed at the anode, and the spent liquor from the electrolytic vats, containing the regenerated acid, is used over again in the treatment of further batches of ore. The process forms therefore a cycle.

The operations, (roasting and lixiviation of the ore, accompanied by electrolytic deposition of the copper from a sulphate solution), are so simple, and so well known in all particulars, that it would seem as though the extraction of copper by electrolysis in the manner indicated should have been worked out long ago. But with the roasting methods heretofore employed for the purpose of oxidation, sufficiently pure solutions of copper sulphate could not be obtained for electrolysis under working conditions and this fact has constituted one of the greatest impediments to the introduction of humid methods of copper extraction. In carrying out the process, other soluble metallic salts were taken up from the ore by the solution, among these being ferruginous compounds which introduce complications into the operation. For instance, when an electric current is passed through a solution containing sulphuric acid and ferrous sulphate, the latter is oxidized to ferric sulphate, and this salt vigorously attacks the copper deposited upon the cathode, rapidly dissolving it. As a matter of fact, when a solution of ferruginous copper sulphate is electrolyzed using insoluble anodes, not only is the quantity of copper deposited much less than that which theoretically should be expected, but in addition the metal obtained is fragile and of subordinate value commercially speaking.

CARE IN ROASTING.

In order that the least possible quantity of iron should pass into solution, and at the same time to diminish losses when treating sulphide ore, roasting should be conducted in such a manner that only ferric oxide is produced, which of course is insoluble in weak acids. However, even when exercising every precaution, roasting cannot be carried to theoretical perfection, and a certain quantity of iron invariably passes into solution.

Even when the first solution off the ore contains a quantity of iron so small as not to materially interfere with the operation, nevertheless the proportion grows as the process is repeated, until finally the accumulated ferric sulphate dissolves as much copper from the cathode as the current deposits—that is to say, deposition of the copper ceases. Under usual conditions the high cost of acid prevents the employment of fresh lixiviant with each new batch of ore, and discarding the spent liquors is therefore impractical. As a remedy for this evil it has been proposed to purify the solutions before submitting them to electrolysis by precipitating the iron with calcium carbonate. But the ferric hydrate thus formed carries down with it notable quantities of copper, which fact renders this method also unavailable.

The employment of diaphragms in the electrolytic vats overcomes to some extent the baneful influence of iron salts, provided the space surrounding the anode can be kept filled with dilute sulphuric acid. The acid then prevents contact between the anode and the ferruginous salts, impeding oxidation. Nevertheless the use of diaphragms has its disadvantages also: it complicates the apparatus, necessitating two separate currents of electrolyte, with corresponding systems of pipes for the anode and cathode baths. It also frequently happens that diaphragms break during the operation, or while charging the vats, and the deposited copper, or the electrolyte, becomes contaminated. Furthermore, the construction of vats fitted with diaphragms is expensive and complicated, and frequent repairs cause much work and expense. For these reasons, electrolytic methods employing diaphragms are not to be recommended for practical work—at least, experience up to the present time has indicated that such contrivances should be avoided where possible.

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† Mining Engineer and Metallurgist, Riverside, California.

OVERCOMING DIFFICULTIES.

The Laszczynski process is said to have overcome the difficulties enumerated in the following simple manner. In the first place, the anodes employed consist of refined lead-plates enveloped in a coarse cotton texture (fustian) in close contact with the surface of the plate. The effect of this simple disposition is said to be surprising. Although the solution may contain large quantities of ferruginous salts, the deposited copper has a beautiful appearance and the electrolyte is said to yield practically all of the copper originally in solution. The amount of copper deposited is almost that which

to the speed of diffusion, then few, if any, of the iron-ions will reach the anode, and the troubles due to anodic oxidation of the ferrous sulphate are overcome. That such a state of equilibrium can be brought about is said to have been confirmed by actual working results.

It is evident that the thickness of the envelope must be in inverse proportion to the strength of current; because, the thicker the texture, the greater will be the distance through which diffusion must take place to reach the anode, and the longer the time required. Increasing the strength of current charges more

by means of sulphuric acid derived from electrolysis of the lixivium, while the sulphuric acid contained in the sulphate formed in the roasting compensates in part for that lost in the tailings.

The degree of concentration of the electrolyte may vary greatly without seriously affecting electrolytic treatment. The relative proportion of copper sulphate and copper oxide in the roasted product therefore does not necessarily have to be constant. It is sufficient that the average ratio existing between these compounds should remain approximately the same over an extended period.

The roasting must be carried to a point

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ERRATUM.

Contrary to our expectations, it was announced on Saturday evening by one of the "units" of the Utah Copper Company's subsidized press bureau, and after our regular issue had gone to press, that the production of copper by the Utah company for the month of October was 7,582,219 pounds. This being so greatly in excess of our predictions by reason of the reported lower grade character of the ore treated for that month, viz., 1.30%, we at once called up our special correspondent and demanded an explanation of the disparity in values reported, and learned that the figures furnished us were the result of steam shovel ore received during the early part of the month, and that the grade of the ore mined underground from the Boston Consolidated property for the month was unusually high, and, therefore, brought the combined average for the month up to 1.70%, but that he had neglected or forgotten to report these changed results. He also reports considerable increase in the quantity of ore extracted from UNDERGROUND for the October month and suggests that this was induced by the higher grade character of the underground ore, which is being drawn from comparatively narrow channels or veins, and also from the purpose of the management to make the best possible record of production at this particular time.

During the month of October 380,050 tons of ore were treated at the mills. Of this amount 78,700 tons, or a little more than TWENTY-FIVE PER CENT, were derived from the underground works upon the Boston Consolidated properties, and compares with FOURTEEN PER CENT derived from underground mining at this time one year ago, as shown by the sixth annul report, dated November 1, 1909, which states:

"The tonnage of underground ore mined was further reduced during the quarter to 14% of the total ore mined. At the close of the quarter underground work had been entirely discontinued, with the exception of a moderate amount of development work, and in future all but an insignificant portion of the tonnage, which will come from development, will be extracted by steam shovel mining."

Assuming the latest figures of value to be correct, i. e., 1.70%, or 34 lb., of copper per ton of ore—if the reported yield of copper for the month be correct—19.53 lb. were recovered per ton of ore treated, being only 57% of the original contents of the ore.

velope, and it follows that the time required for such diffusion depends upon the thickness of the texture. If therefore a current strength is applied which causes a movement of the iron-ions towards the cathode approximately equal

ly fifteen horsepower have been used.

As sulphides predominate in the ore it has to be roasted, thereby producing a mixture of sulphates and copper-oxides. The copper oxide formed is changed over into sulphate in the course of operations

entering the furnace was preheated as the briquettes were cooled. The kiln described is strikingly like the one used for a somewhat similar purpose in Arizona, (described in Mines and Methods, November, 1911, page 356), a fact which

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The satisfactory action of the envelope surrounding the anode may be explained as follows: The lixivium which permeates the texture is at first identical with the rest of the electrolyte. If, however, the bath is agitated, (which is essential in obtaining a good deposit of copper), that portion of the lixivium which is enmeshed in the texture remains practically undisturbed. Furthermore, electrolytic treatment of the lixivium produces liquors of varying densities, and those of high specific gravity enter the pores of the texture very slowly. It follows that as the texture is very tightly wound around the anode, the latter remains surrounded with a solution practically in repose, even though the rest of the electrolyte be in a state of violent agitation.

When the electric circuit is first closed, everything proceeds as though there were no envelope. However, as the ferric and ferrous ions are cathions, that is, as they move from proximity of the anode in the direction of the cathode, it transpires that within a short time after the current has been passing through the electrolyte the ferruginous salts have for the greater part left the vicinity of the anode. Then, as there are no salts of iron near the anode, such compounds are not subjected to the action of the SO_4 ions liberated at that electrode, as there are none of these salts present to be oxidized. The result is that there are no ferric salts formed which might act upon the copper deposited upon the cathode. The only way that iron-ions can reach the anode is by diffusion through the envelope, and it follows that the time required for such diffusion depends upon the thickness of the texture. If therefore a current strength is applied which causes a movement of the iron-ions towards the cathode approximately equal to the speed of diffusion, then few, if any, of the iron-ions will reach the anode, and the troubles due to anodic oxidation of the ferrous sulphate are overcome. That such a state of equilibrium can be brought about is said to have been confirmed by actual working results.

It is evident that the thickness of the envelope must be in inverse proportion to the strength of current; because, the thicker the texture, the greater will be the distance through which diffusion must take place to reach the anode, and the longer the time required. Increasing the strength of current charges more ions and starts them off towards the cathode, therefore the movement of the cathions is increased relative to diffusion, and less thickness of envelope is required.

It is only when the envelope is placed tight against the anode that the desired results are attained. If it hangs loose, or if it is placed on a frame at some distance from the electrode, then diffusion is assisted by vertical currents set up in the liquor through difference in specific gravity of the solutions, and in this manner iron-ions may reach the anode. When properly adjusted, the envelopes do not interfere with escape of oxygen liberated at the anode, and it is said that a lixivium containing twice as much iron as copper can be electrolyzed with close to theoretical current-efficiency. It is interesting to note in this connection that in the Farnham electrolytic cell (U. S. Patent No. 1,006,836) the anodes are made hollow and are pierced with a multitude of holes. The diaphragms (asbestos, burlaps or canvas) are secured to the outside of the anode, which gives them a rigid backing.

ORIGINAL PLANT IN POLAND.

The first plant operated under the Laszczynski system was put up at the Miedzianka copper-mine near Kielce-Checiny in Russian Poland, not far from the German and Austrian frontiers. The ore exploited contained azurite, chalcopyrite, malachite and grey-copper. The richest grade carried as high as forty per cent copper; the poorest, approximately fifteen per cent.

In the beginning the works were designed for an approximate output of 100 kilograms (220.46 lb.) copper in 24 hours, but provision was made for increasing the production should it seem advisable to do so. As water-power was available, a 50-horsepower Francis turbine was installed, but to date not over approximately fifteen horsepower have been used.

As sulphides predominate in the ore it has to be roasted, thereby producing a mixture of sulphates and copper-oxides. The copper oxide formed is changed over into sulphate in the course of operations by means of sulphuric acid derived from electrolysis of the lixivium, while the sulphuric acid contained in the sulphate formed in the roasting compensates in part for that lost in the tailings.

The degree of concentration of the electrolyte may vary greatly without seriously affecting electrolytic treatment. The relative proportion of copper sulphate and copper oxide in the roasted product therefore does not necessarily have to be constant. It is sufficient that the average ratio existing between these compounds should remain approximately the same over an extended period.

The roasting must be carried to a point where no undecomposed sulphides remain in the roasted material, because sulphides do not go into solution in dilute sulphuric acid and therefore any of these compounds present would constitute a direct loss. The percentage of extraction manifestly affects economic results, and too low an extraction caused by inadequate oxidation of the raw sulphides reflects upon the applicability of the process. The majority of roasting furnaces are not well adapted to the complete oxidation of copper sulphides, which can be ascribed to the fact that in smelting copper-ore it is not necessary, nor even desirable, to attain a perfect roast, and it is for this latter method of reduction that most roasting furnaces are designed. Because of the inefficiency of such apparatus, in the introduction of the Laszczynski process much experimentation was necessary to discover a method of roasting appropriate to the purpose in hand. After many ineffectual attempts, the following means of reaching the desired end was devised, and very satisfactory results are said to have been attained.

The mineral was first pulverized in two cylindrical grinders, so as to pass through a 1 mm sieve and then mixed with five per cent of clay and moistened so as to form a plastic mass suitable for molding in a press. The briquettes thus obtained were then dried on top of the furnace before being roasted. The roasting furnace consisted of a shaft of rough masonry, with firing-door half-way up the side. The briquettes were charged at the top through an opening which could be closed by an iron plate, and passed down through the furnace, being cooled by the air drawn into the shaft after they had passed the firing door. At the bottom of the structure was a discharge-opening, provided with a contrivance for regulating the draft. In this manner the air entering the furnace was preheated as the briquettes were cooled. The kiln described is strikingly like the one used for a somewhat similar purpose in Arizona, (described in Mines and Methods, November, 1911, page 356), a fact which

is interesting in that it shows how, when occasion arises, practically the same problem may be attacked simultaneously at two widely separated localities, and solved in the same manner.

The briquettes are said to be sufficiently porous to permit a thorough roasting of the mass, the burning of the sulphides increasing the draught and facilitating the oxidation. The operation of this furnace is said to be satisfactory, all of the copper being transformed either into oxide or sulphate so that no insoluble copper-sulphide remains in the roasted ore.

LEACHING AND ELECTROLYSIS.

The roasted ore, coming from the furnace in condition to be readily crushed, after comminution is placed in leaching-vats and subjected to successive lixiviations, using as lixiviate the liquor from the electrolytic vats which contains approximately seven per cent free sulphuric acid, and from one to one and a half per cent copper. This operation is conducted in such a manner that the partially saturated lixiviate is brought into contact with fresh roasted ore, while the acid solution from the electrolytic vats is used on partially lixiviated material. This is, of course, the application of the principle of contrary streams. As electrolysis is always accompanied by more or less evaporation of the liquid, and furthermore, as a certain portion of the liquor always adheres to the tailings, such losses are made up by additions from wash-water used in washing the residues from the leaching vats.

The solution of sulphate of copper (lixivium) from the leaching vats contains approximately five per cent copper and one per cent free acid. It is turbid and must be passed through a filter-press before being sent to the storage tanks placed below the leaching vats from which the clear solution, now ready for electrolysis, is drawn as required.

Electrolysis is carried out in vats made of wood which are lined with lead, similarly to those used in copper-refining establishments. Each vat is equipped with nine anodes, composed of plates of lead about one eighth inch thick, covered with cotton texture, and eight cathodes, consisting of thin copper leaves—so-called, mother plates. Between each anode and cathode is placed a wooden agitator which serves to maintain the electrolyte in continual agitation. Copper rods, placed longitudinally over the electrolytic vats, serve as current-conductors to the anodes and cathodes respectively: all anodes in each bath being connected to one of these rods, and all cathodes to the other. A difference between the Laszczynski vat and those used in copper refineries, consists in the use of insoluble anodes in the former, as well as in keeping the liquor in movement with agitators in place of injecting air.

When the electrolyzing vats have been filled with lixivium, the current is turned on. Each vat contains about 35 cubic feet of liquor, and is supplied with 900 amperes of current which shows a drop of from 2.25 to 2.50 volts in potential per vat.

As already explained, the current effects deposition of copper upon the cathode, and produces free sulphuric acid and oxygen at the anode: the oxygen is allowed to escape into the atmosphere. The amount of copper deposited per ampere-hour is said to be as high as 1.1 gram, which is approximately equivalent (92.9%) to the quantity (1.184 gram) theoretically attainable. If one ampere of current will deposit 1.1 gram copper in one hour (irrespective of voltage), to deposit a kilogram of the metal will require $\frac{1000}{1.1} = 909.1$ ampere-hours. As stated above the mean voltage employed was $\frac{2.25+2.5}{2} = 2.375$ volts. A kilowatt-hour (the conventional unit upon which electric power is sold) equals 1000 ampere hours at one volt pressure, or one ampere-hour at 1000 volts, or 421.05 ampere-hours at 2.375 volts, therefore the kilowatt-hours expended in depositing one kilogram of electrolytic copper under conditions as stated, amounts to $\frac{909.1}{421.05} = 2.16$, measured at the vat, or from 3.2 to 3.5 steam horsepower hours, according to size and efficiency of the dynamo and length of electric circuit. Hence, for the production of a ton (1000 kg=2204.6 lb.) of copper daily, there will be necessary approximately $\frac{3.2 \times 1000}{24} = 134$ steam horsepower, when losses in dynamo and conductors are taken into account.

It is evident from the foregoing figures that on a basis of steam power costing $60.00 per annum (365 days @ 24 hours), the expense for current used in depositing electrolytic copper in the manner described would be one-half ($0.01 per lb.) that of precipitating with iron at one cent per pound for that reagent, using two pounds iron to precipitate one pound copper in the form of cement-copper. However, electrolytic precipitation has the advantage of producing a finished product, (instead of the undesirable mixture of copper with impurities known as cement-copper), and the bath-liquors are at the same time regenerated and made available as lixiviant for treating a further batch of ore—two very important considerations.

Because of the limited production of the Miedzianka mine, only four electrolytic vats were put into use, and these furnished approximately 100 kilograms of copper daily. The current was supplied by a dynamo with capacity of 900 amperes per hour at ten volts pressure.

The lixivium was subjected to the action of the current until its contents had been reduced to approximately 1 to 1.5 per cent copper, while the proportion of free acid rose to about seven per cent. the gradual discoloration of the liquor indicates the advance of the treatment. About 35 hours were necessary for the deposition of all the copper contained in the liquor held by a vat of 35 cubic feet capacity.

After the removal of the copper the liquor is returned to the leaching vats where it takes up more copper, and this operation is repeated until the cathodes reach a thickness of from three-quarters to one and three-eights inch, which requires approximately one month. Then the plates are taken out and replaced by new ones.

The copper deposited on the cathodes possesses a uniform bright-rose color. It is said to be nearly chemically pure: purer than copper produced by electrolytic refineries generally. It gives out a metallic sound when struck and can be put on the market without further treatment.

In preparing the cathode plates, sheet-copper is coated with graphite and suspended in an electrolytic bath. When there has been deposited on each face approximately 1-32 inch of copper, the sheets are taken out and the deposited metal is stripped off: these strips then serve in turn as cathodes.

The process is, therefore, obviously simple, and should call for very little expert supervision: in fact, it is said that practically any intelligent workman can be sufficiently instructed so as to be able to take charge of such a plant. At the Miedzianka mine it was found possible to place operations in the hands of an old miller who happened to be living in the neighborhood.

Should it be desirable to recover the oxygen separated at the anode and thus realize profit from a by-product, this can be done; but then the construction of the electrolytic vats becomes more complicated, and the simplicity of the apparatus is affected, which simplicity constitutes one of the advantages of the system.

SECOND PLANT IN SIBERIA.

A second establishment employing the Laszczynski process has been in operation since 1908 at Kakaralinsk in Siberia. The reasons given for deciding on the adoption of the process in this particular case were: (1) the simplicity of installation and certainty of action; and (2) the fact that the nearest railroad station was 700 kilometers distant from the mine, which effectually precluded shipping-in bulky supplies. This plant was designed for a daily production of 1.1 metric tons of

copper, but at present only about half a ton is turned out. On the surface of the deposit oxidized ore is found which does not require roasting; at greater depth it is naturally expected that sulphides will be encountered.

The installation is similar to that at Miedzianka, but there are more electrolyzing vats, and these are of larger capacity. The leaching is carried out in the manner already described. As water power was not available, recourse was had to steam. There being no coal nearby, wood is used as fuel. The consumption of wood is said to be large, for it not only serves as a source of power, but also is used to heat the works and living houses of the employees—by no means an inconsiderable item in that inhospitable climate.

Many difficulties were encountered during construction, and while putting the plant into operation, as would be anticipated in a region almost totally devoid of means of communication, and extremely barren. For instance, when it was found that a certain rock-breaker did not respond to the work required of it, eighteen months passed before another could be obtained from Europe to replace it. In the beginning of operations the only food available was mares' milk. Scarcity of water also created complications. In summer water is very scarce and contains considerable chlorides, which corrode the lead and diminish the effectiveness of the electric current in the electrolytic vats. A remedy for this evil was found in purification of the water.

The liquor remaining in the residues after lixiviation carries with it very little copper: by washing, the amount is brought down to a small fraction of the total originally in the ore, so that the loss from this source is unimportant—in the electrolytic vats there is, of course, no loss of metal whatever, because that remaining in the lixivium goes back to the leaching vats.

It is thought by Stoeger that a plant designed to produce one metric ton of copper daily, provided with the necessary solutions, should cost (in Spain) approximately 45,000 marks ($11,250), including electrolytic vats, dynamo, storage tanks, pumps and accessories. Where steam power is not unduly expensive, the cost of electrolytic treatment, including amortization, should be about the same as precipitation by means of iron. However, there is in favor of the Laszczynski process the fact that electrolytic copper is produced, which can be sold for commercial use, whereas cement-copper resulting from precipitation by iron must be smelted and refined before it becomes a marketable product. The difference between these two products, viewed from the standpoint of selling price, is of course in favor of the electrolytic copper, and this fact in itself is thought to justify the adoption of the last named method when conditions permit.

ADVANTAGES OF PROCESS.

In recent times the electrolytic manufacture of weldless copper-tubing, as well as plates and wire, has assumed considerable proportions. All such methods of manufacture make use of soluble copper anodes and call for refined metal of great purity. By adopting the Laszczynski process the required quality of metal is obtained direct from the ore, and the manufacture of commercial forms of copper, it is said, may be carried on without difficulty.

It is self evident that a plant employing a process based upon the application of electric energy should be located as close as possible to a source of cheap power. It is apparent, therefore, that such methods of reducing copper ore are particularly adapted to localities where water-power can be developed but where fuel is expensive.

In favor of electrolytic methods of treatment, as with leaching processes in general, is the fact that the percentage recovered is high, and therefore the maximum amount of copper may be extracted from an ore. This may become a feature of much importance in the treatment of low-grade ore where wet-concentration methods leave from 25 per cent upwards of copper in the tailings. Furthermore, some ore cannot be smelted at all per se, or the expense for fluxes and fuel may consume a large portion of the profits, so that such methods of reduction affect the value of a given property. In such cases some leaching process is the rational recourse, and with the number to choose from, some one of them ought to meet the conditions in most instances. At Kakaralinsk, owing to absence of suitable means of communication, bringing in iron for cementation could not be thought of, consequently there remained nothing to do but to apply an electrolytic treatment, which was done.

In the Laszczynski process it is said that the presence of iron, zinc, lead, arsenic, and antimony in an oxidized ore exert no prejudicial influence. Lime, or other compound soluble in sulphuric acid, are naturally injurious, because such substances bring about wasteful consumption of acid.

Heretofore it has been found necessary to put up sulphuric acid chambers, or to purchase acid, where this reagent was employed for leaching purposes; but introducing sulphur-dioxide into the bath, as described in preceding articles, has been found an economical method of making up loss of acid occasioned by the operations.

Briquetting sulphide ore is not a suitable method in all cases where roasting is necessary. It happens that cupriferous pyrites, in very fine state of division, must often be treated in mechanical roasting furnaces to render the copper content soluble. In such cases not only is it essential that all the sulphur should be oxidized, but also that the temperature should not go above a certain point, because then insoluble compounds composed of oxides of copper and iron are formed. This is the reason why pyrites roasted in the usual manner often cannot be satisfactorily lixiviated with dilute sulphuric acid even after repeated roastings. In carrying out the first roast, proper precautions as to temperature may not have been taken, which results in the difficulties described.

The Laszczynski process is said to be applicable in all cases where the extraction of copper by humid methods appears advisable; for example, in the treatment of low-grade ore, or of pyrites when the leached material is to be smelted for iron after the copper has been removed. As it has been shown in the two Russian plants referred to above that works of small capacity may be economically operated, it can be expected that other mines similarly situated, from which ore cannot at present be economically shipped, might be handled along the same lines. The process might also be economically adopted in chemical factories where pyrite is burned to make acid, even when the copper content of the ore is not large. With a process which turns out copper in as pure a form as the one under consideration, the necessity of disposing of cupriferous by-products to refineries might be avoided.

In electrolytic refining establishments it is necessary to change the electrolyte when the amount of impurities assumes excessive proportions. As a usual thing such impure solutions are treated so as to convert the contained metal into cement-copper, or into sulphate of copper. As in such works baths and current are already at hand, it is possible with some simple additions to arrange for extracting copper from the residual liquors without making by-products: all that is necessary is to add some lead anodes wrapped in cotton texture. By applying proper current-density, it is said that all the copper can be removed from such residual liquors.

To recapitulate, the advantages claimed for the Laszczynski process are: (1) simplicity of installation; (2) positive action and small cost of operation; (3) high priced supervision not required; (4) in case of strikes it is easy to substitute other workmen, which is not the case in smelting works; (5) small loss of copper in tailings—therefore, availability for low-grade ore; (6) avoidance of melting oper-

ations of all kinds; (7) possibility of producing metal in commercial forms direct from ore; (8) applicability to small works located in proximity to small mines; (9) possibility of extracting copper profitably from impure solutions; (10) utilization of water-power for metallurgical purposes where fuel for power, and iron, are not available.

What is very much needed at the present time is some such process as the one described, which is not very expensive to put in, and which turns out copper in a commercial form. Such a process might render profitable many small mines which are now idle from one cause or another. From published accounts the Laszczynski process appears to have met the required conditions at two properties—in any event its merits in a given case are easy to establish.

MODERN MINE BUILDER

From an Arizona prospect to a transcontinental railway would seem a far cry, but that is what is eventuating at this very moment, says the Southwestern Mining Record.

Not more than a score of years ago, Dr. James Douglas, now head of the Phelps-Dodge interests, sat mooning and ruminating in a canyon at the place now known as Bisbee, Arizona. The ore had given out in the then prospective Copper Queen mine. The doctor's eastern associates had manifested a bad case of "cold feet."

Notwithstanding these vitally discouraging circumstances, the doctor's faith never faltered nor did his courage swerve. But the coincidence of the ore being lost and the unwillingness of his eastern associates to further furnish money for the development of the mine were of such seriousness that the doctor felt depressed. And that was why he sat down, one night, lonesome, dejected and absorbed in thought, in a canyon which is now one of the main thoroughfares of Bisbee.

"The formation is perfect," soliloquized he. "The amount of ore in the original discovery was too great to have been anything else but the detached portion of a great body."

"Faith moves mountains," flashed through the doctor's mind; and right then and there did he determine that faith should reveal the secret of a mountain. Arising from his discouraging reflections, he was amazed at the change which had come over him. He was really lighthearted and buoyant, and turning to wend his way to his makeshift office and sleeping quarters he was impelled to give one glance backward at the mountain, and, surveying it from the base to apex with a look that was almost menacing in its intensity, he mentally said: "Thy secret thou shalt unfold unto me."

The die was cast with the doctor. The very next day saw him astride his faithful horse on the long and weary jog to the nearest rails, at Fairbank, Arizona. Pitilessly did the sun beat down upon him, painfully did his mount amble through the sands of the desert and the steep, rocky passes of the mountains; but the doctor was oblivious to it all, for he was dreaming dreams—dreams of the kind which when realized, make for the betterment and happiness of mankind.

So absorbed and obsessed was he with the idea of wresting the secret from that mountain that the journey from Fairbank to New York seemed scarcely a day. Arriving in the metropolis, he found, as had many before him, that although faith may move mountains, it has oft failed to move financiers.

Through weeks of varying fortunes he passed, one day hopeful, the next despairing, until finally through his sublime faith, courage and persistence, he secured one hundred and fifty thousand dollars with which to conquer the mountain.

Every mining man knows that one must be especially favored of Providence if he develop a copper mine with one hundred and fifty thousand dollars. Many have tried, but few have succeeded. But the doctor seemed to be one of the elect, for he found the main body of the Copper Queen mine. And even then, for a few years, things went in a way to try a man's soul. Copper was low, lower than now, and the bullion had to be transported by team to Benson, a matter of seventy miles or more.

Nothing daunted, the doctor persisted, and ere long was figuring on a railroad connecting the mines with the Southern Pacific and Santa Fe systems. The railroad project rather staggered the easterners, who were required to finance the venture; but finally the railroad was built—and paid for itself the first year.

The railroad venture was an eye-opener to the easterners, who had fatuitously thought railroads, reasonably capitalized, paid only five and six per cent, as do the shamelessly overcapitalized roads of today.

The lesson was not lost upon the astute doctor, however, and he suddenly began to realize that he had not only wrested a secret from a mountain, but from a railroad as well.

The mines now paying profits, it was thought advisable to build a line to El Paso. This was speedily done. Then the original copper company known as the Copper Queen bought a coal mine in New Mexico and a railroad connecting it with El Paso. The doctor seemed to have been invested with a magic wand, for this moribund coal mine and railroad immediately developed into big money-makers.

Then a mine at Nacozari was acquired, and another at Morenci; and all, under the guidance and management of Doctor Douglas, proved to be good payers. The result of all these paying concerns was that a stream of wealth began to flow into the coffers of the eastern associates of the doctor until they were threatened with engulfment by the very plethora of money.

This money sought investment. Mines cannot be bought every day, and certain it is that they cannot often be found even at the behest of money. Therefore the surplus had to be invested in something ready at hand.

Then the doctor bethought himself of railroads—railroads that when reasonably capitalized make profits exceeding even those of mines, and increase in value with time; whereas mines inevitably tend toward exhaustion. Surveying the railroad field, it was determined that a transcontinental line—one from sea to sea—would be of the kind best calculated to insure profit and permanency. But as even transcontinental railways cannot be bought every day, some circumspection, judgment and diplomacy were requisite to the acquisition of one.

But the man whose faith had wrested the secret from a mountain was equal to the problem now confrontinkg him; and ere long, without any fuss or feathers, stock was beginning to be secured in the Rock Island Railway, a moribund, mismanaged road, running from Chicago to a place where it seemed to peter out altogether in Kansas. The magic wand was applied to it, and the derelict responded most gratifyingly to its revivifying influence. Soon there were Golden State Limiteds running over the line. Eighty-five pound rails replaced the streak of rust. Double tracking soon became necessary. Traffic increased to an incredible degree. The road now had its terminus at El Paso, where it necessarily had to disgorge its huge business into the maw of the Southern Pacific.

This evidently was too unreasonable to last; so now we see the extension to Tucson. Soon, it seems, we shall see a further extension—perhaps to Phoenix. And then, look out, for it will be a "dash for the coast," an irresistible, all-conquering dash that will land the road in whatsoever port it elects to make its western terminus.

And thus we think we "have made clear a thing that already seemed clear so clearly that it seems perplexed"—the development of an Arizona prospect into a transcontinental railroad.

Mail this number to a friend.

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CONTENTS:

Last month we had a few words touching upon the subject of how the Guggenheim's had been gold-bricked in various ways. We have since been asked if the notorious family did not get another "copper-plated gold brick" when it went into Utah Copper. To that question we may answer: "Not exactly; the Guggenheims went into Utah Copper for the particular purpose of securing a contract to smelt that company's mill or mine products at a price that would insure them against loss in the purchase of shares at $20 or so, even though they dropped to nothing before they would get a chance to unload." That is all that it is necessary to say at the present time on that subject.

UTAH COPPER

Recent Issue Of New Shares.
Production Estimates Shrink.
Working Both Ends on Labor.
Some "Utah Copperettes"

The Boston News Bureau of recent date has the following:

"Several holders of Bingham & Garfield R. R. Co. 6 per cent bonds have signified a desire to exchange their holdings for stock of the Utah Copper Co., which guarantees the issue.

"When the bonds, totaling $2,500,000 were issued in 1910, it was stated that they were to be exchangeable afted July 1, 1911, for the ensuing three years at the option of the holder into stock of the Utah Copper Co. at $50 a share.

"In order to care for such conversion the Utah Co. has made application to list 55,651 shares of additional stock to be issued from time to time."

To the uninitiated the disparity between the face value of the total bond issue and the gross amount of the nominal value of the authorized issue of shares thus made available for exchange, requires some elucidation. Besides, "in order to care for such conversion"—or exchange—the average reader will doubtless fail to conceive of any necessity for "listing" the 55,651 shares as a condition precedent to such exchange. At the present rate of dividend disbursements, Utah Copper shares at $50 return the same rate of interest per annum as that paid—or promised—to the holders of the bonds, except that quarterly disbursements are made to the shares, whereas interest on the bonds are promised only semi-annually; and in this respect the shares appear most attractive, especially in view of the higher market quotations that are daily recorded in their favor. But the bonds are secured, principal and interest, by mortgage upon all of the property of the Utah company, which—if regarded as safe and sound—should give these bonds a ready market value on a basis of four per cent interest, or $75 for the exchange rate of each share of Utah stock. But this is immaterial, and is mentioned only to indicate the degree of respect in which this class of securities is held as compared to other industrials.

It will be observed that the exchange value placed upon the shares totals $2,782,550, being $282,500 in excess of the total par, or exchangeable value of the bonds, and an excess of 5,651 shares of Utah stock over and above the number issuable in exchange for the entire bond issue. The probable explanation of this disparity will be found in the fact that no interest has ever been paid upon the bonds and, as the defaulted interest would attach to the mortgage lien, it could easily be made to appear that the issue of sufficient additional shares to cover accrued interest was justified. It will be remembered that these bonds were underwritten by Hayden, Stone & Co., and as the public did not participate to an appreciable extent in their purchase, the burden—as usual—fell upon the inside, or "pooled interest," so that an adjustment of interest or commission could be easily arranged.

Evidently the sole purpose of conversion of the bonds at this time was to "work off" the shares upon the public and thereby relieve the "pooled interest" of a portion of its burden. And in this connection it will be of interest to note what measure will be adopted to recoup the additional $2,500,000 or more which was likewise advanced by the pool to enable the management of the Utah company to complete its B. & G. railroad.

UTAH COPPER PRODUCTION

Referring to the visit of Manager Jackling and associates to the Butte district a few months ago, a Boston paper published the following telegraphic special from Butte:

D. C. Jackling, Charles M. McNeill and George Bradley of the Utah Copper Co., are in Butte making an examination of the Butte & Superior mines and the new concentrating process. They declare this process is a decided success. Mr. Jackling says:

"At no time since I have been in the copper business have I known stocks to be so low as at present. When industrial conditions improve this will have its bearing.

"Utah will produce about 150,000,000 pounds of copper this year against 20,000,000 pounds seven years ago. The low price of copper has its effect upon the state's production, but the POTENTIAL condition is good and will improve as the market improves."

On the 10th of the present month,

Thompson, Towle & Co., in their weekly news letter—an official organ of the Utah Company—published the following:

"A preliminary estimate of Utah Copper's operations for the year 1911 places the gross production of copper at 98,000,000 pounds, and the net production, after allowing for smelter deductions, etc., at 93,000,000 pounds. This latter figure compares with 1910 net production of 85,644,511 pounds, or an increase for the year of approximately 7,350,000 pounds."

It will be observed that the actual yield of copper by the Utah company, as officially estimated at the close of the year, fell short of the estimate of Manager Jackling—made a few months previous—by fifty-seven millions of pounds, or THIRTY-EIGHT PER CENT. The only remarkable feature of this fact, however, is the striking relation which it bears to the shrinkage in grade of the "sixty-two millions of tons of TWO PER CENT ore," so frequently mentioned in the manager's earlier "Reports," which later shrank to about one and one-quarter per cent copper, being almost exactly THIRTY-EIGHT PER CENT, and what is still more remarkable, the volume of ACTUAL ORE was found to depreciate in even greater ratio; but the deficiency was partially made good in the masterful acquirement of the Barnsdall-Pay Roll claims, as related in this journal for December, 1910. It may be observed, however, that whilst Manager Jackling's estimate of the quantity and quality of the ore and—as a consequence—the yield of metal has been slightly at fault, it is believed that the "potential condition" of the several elements named has remained fairly constant.

WORKING BOTH ENDS

Under the caption, "Workmen are Prey of Labor Agents; County Attorney Investigating Charge, Asks Mining Companies to Take Action," the Bingham-Press-Bulletin of recent date publishes the following:

Complaints have been made to the county attorney that Greeks and other foreign laborers employed by the Utah Copper Company and the Bingham & Garfield Railroad Company have been compelled to purchase their jobs and pay tribute to labor agents to hold them, County Attorney I. E. Willey yesterday directed letters to the two companies, calling their attention to the fact that such practice constitutes practical slavery, and is in violation of the constitution and statutes of the state of Utah on peonage.

The letters cite the law which makes such a system of tribute from laborers a felony, and calls upon the proper officials to take immediate steps to put an end to the system.

The action of the county attorney was brought about through a letter received from John H. Stampolas, secretary of the Independent Grocery company of Bingham, and upon information which has been laid before him by residents of Bingham.

The letter from Stampolas charges that a well-known labor agent of Salt Lake, who furnishes foreign laborers for mining and railroad companies in Utah and adjoining states, requires Greeks who secure jobs from the Utah Copper company to pay him $20 to get the job and $1 a month for each month they work.

It is alleged that if the laborers fail to keep up their monthly tribute payments they are discharged.

The same conditions are said to exist with reference to the Bingham & Garfield Railway Company.

Mr. Willey believes that the companies when their attention is called to the violation of law, will have the proper officials take hold of the matter and see that this system is stopped.

The method of supplying corporations and contractors with foreign labor related in the foregoing, is not new or unusual in Utah and other Western States. In fact, the custom has come to be regarded by those who employ large numbers of laborers of that class as essential, because of the fact that these people, aside from being enrolled as regular members of "labor unions," are also under a system of peonage absolutely controlled by a padrone upon whom they depend solely in all matters of securing employment and to whom, in addition to a fee, paid on entering employment, they pay weekly or monthly contributions, according to conditions involving the positions secured for them. But this is the first instance of which we have ever heard wherein failure to pay "monthly dues" subjected the victim to peremtory discharge by the employer. Such condition could only be enforced by the connivance and participation of the manager or superintendent of the business or corporation employing such labor.

It would be interesting to know what manner of reply Manager Jackling or his assistant, Mr. Gemmel, of the Utah Copper Company, or Mr. Chief Engineer Goodrich, of the Bingham & Garfield Railroad Company, will make to the letters of inquiry said to have been addressed to the officers of these companies by County Attorney Willey. But it is safe to assume that this will never be made known to the public and that there will be no prosecutions or other unpleasantries to disturb the very cordial relations which exist between the management of the Utah Copper Company and all important State and local officers.

It will probably surprise some of our citizens to know that while very few of these foreign laborers can speak or understand a word of the English language, and are only known or designated by their employers by a number on the "tags" which they wear or carry when at work, yet many of them are full-fledged American citizens. In this connection a ludicrous if not amusing incident occurred—shortly prior to the last general election—during the progress of the trial of an important case in which the Utah Copper Company was a party. It appears that on two occasions during the trial squads of these foreigners—in the employ of the Utah Copper Company—were brought into court and put through the form of naturalization, the trial of the case being suspended by the court pending the more important process of equipping some thirty illiterates with the right to vote at an important election at which the court judges were to be selected.

No, there will be no prosecutions on account of "graft" imposed upon the Greek laborers, and the process will be continued just the same; but the Bingham newspaper—for its indiscretion—will probably find its subscription and advertising patronage greatly diminished.

COPPER STOCKS AND METAL

Every day, almost, witnesses a new batch of "publicity" being ground out by the market-boosting machines which are such an important part of the Utah Copper-Ray Con.-Chino companies' "visible supply" of assets, or equipment. This stuff is becoming almost as nauseating and equally as copious as the mass of stuff that used to be worked off on the public during the Nevada gold boom days as news. It is being compiled and distributed in cunning fashion, because governmental investigations are more in evidence than they were a few years ago, but the public are still refusing to take the bait. Stock that will earn "$8.50 a share for thirty-seven years" is not wanted at $56, or $50, or even $38 or $75, because the public has learned and is wise enough to realize that the present owners of such stock would not part with it at any price if the representations made were true.

There also is considerable doubt as to the correctness of the statements being put out concerning the market absorption of copper metal, as indicated in the following abstract from the Mining and Scientific Press' New York correspondence, which appeared on the 13th of the present month:

"In copper there seems to be a good deal of underlying skepticism concerning the recent upward trend in prices. Some of the large consumers are questioning the soundness of the situation and the movement in the shares hardly justifies the fears expressed by some of the producers of a runaway market. While it is not known as an absolute certainty that a pool of big producers was formed during the latter months of last year, it is so asserted in some quarters, the story being that the group included some of the more important foreign agencies, and that a large amount of copper has been accumulated in an endeavor to stampede the American manufacturer into the market. Discussion of the topic with manufacturers reveals the fact that many of them were, and are, uneasy over the prospect of higher prices and no metal on hand, but, while the report of the Producers' association for December, 1911, was expected to make a strong showing, there was a tendency to await developments. If it be true that a group of copper producers working with the larger selling agencies has purchased and is now

ng any large part of the copper is supposed to have gone into conion, if the decrease in the world's supply proves eventually to be acd for in this way, it is safe to say n the end the copper market will more than it will gain."

UTAH COPPERETTES

E. Hazen, representing the Boston Bureau and the Wall Street Jouras in Salt Lake for a day or two the middle of the month. He rode Bingham over the $5,000,000 Bingnd Garfield railroad, it is reported, to see if the steam shovels are still rk removing the capping from the Copper Company's side of the tain of copper ore' on to the opside, owned by Colonel Wall, and isfy myself that the Utah Copper any really and truly has enough ore $8.50 a share per annum, on a 15c. r market, for thirty-seven years." Salt Lake Mr. Hazen expected to go r, from there to Mason Valley, and down for a visit to the Ray Consoli-, Inspiration, Chino and other prop-.

* * * *

t the (Utah Copper) mine between y and twenty-five big steam shovre in operation. It is said that time one of the scoops digs its iron teeth into the porphyry tain it lifts at least $10 worth of r and dumps it into a car. Averthe copper content at 1.5 per cent is thirty pounds of copper per ton. scoopful holds several tons. Five would contain 150 pounds of copwhich, at 14c. a pound, is worth —Salt Lake Herald-Republican, 12, 1912.

d to continue the method of lating, (a la George L. Walker)), tons would contain 300 pounds, $420, and 1,000 tons would con-3,000 pounds, worth $4,200, while scoop of ore containing 3 per cent r at 28c. per pound, or one trainof ore carrying 15 per cent copper, the market at 38c. per pound, it might be by 1915 or 1930, would the figures read like real business being done. When you undertake ture on the future value of Utah er don't be timid or weak-kneed. Go after 'em.

* * * *

mysterious new concentrating deis now being tried out at the Magna of the Utah Copper company. The t gang of farmers, cowpunchers "relatives" which now constitutes subordinate directing force at the mill—or that portion which is still aid of its voice—appears to be at a just bow to describe the newed machine. One, better versed in the names of concentrating machinery than most of the others, says the thing is generally known at the works as "the big drum," which is "a cross between a Cornish buddle and a Callow tank, set wrong end up." It is said to be automatic and absolutely costless in operation and when the intermittent, steady, heaving, pulsating and other features of the rotary and horizontal movements of the "big drum" have been sufficiently brought under subjection it is expected that almost limitless numbers of snare drums can be washed over the rim and saved. These snare drums will be carefully dried and tuned and then shipped and distributed to the various stock market centers of the world, where they will be utilized in making a big "noise" in support of the advancing prices that will be given to Utah Copper shares when the real "unloading" game is being worked on the suckers of London, Paris, New York, Boston and Salt Lake.

KANSAS SMITES THE FAKERS

The Boston News Bureau of recent date, under the caption of "Putting the Vultures to Flight," in caustic language approvingly comments upon the so called "blue sky law," recently enacted by the legislature of the "long-suffering" State of Kansas, as follows:

Massachusetts, at suggestion of its bank commissioner, is thinking of following where Kansas has led.

"Bleeding Kansas" has now become doubly historical, in the past tense. Its pocketbook is no longer freely bled by vendors of fake "securities." These vampires have been banished from the sunflower state.

The ban is the unique "blue sky law," passed last March, which seeks to protect the people's investments by safeguards akin to the supervision and guaranty that the state extends to banks. The law was fathered by its present administrator, Bank Commissioner Dolley, who previously had been unofficially advising Kansans against piratical promoters who would sell even the "blue sky" to the increasingly opulent farmers.

This curious and drastic act provides that any concern offering securities other than government or Kansas state or city bonds, or mortgages, shall file detailed statement of plan of operation, organization, contracts with investors, financial condition, property, and any other information the commissioner may ask. If he finds it solvent, and its proposals are "fair, just and equitable" and "promise a fair return," he shall permit it to do business —bold type declaring this not a recommendation—otherwise shall exclude it. Condition must be reported semi-annually, beside monthly trial balances available to investors, and investment agents be registered yearly. The commissioner has the same power of examination as over state banks, may compel a physical valuation, and may urge receivership if assets fall below liabilities. False statements are punishable by fine of $200 to $10,000, or imprisonment of one to ten years; attempt to do business contrary to the act by fine of $100 to $5000, or not over ninety days in jail.

Only fifty out of 500 applicants have passed muster. The flagrant fakes simply, and silently, crossed the state line, one of them, which had reaped $400,000 in Kansas, going as far as Winnipeg. One brazen mining promoter is now behind the bars. A drain of over $6,000,000 cash a year has been stopped. Better 6,000 automobiles than reams of worthless engravings.

The postoffice, which is soon to report more concretely on the matter, has conservatively estimated that in the past decade credulous dupes nave been swindled out of a billion—thousands of shabby tragedies of shame, tears and blood. Bequests, insurance benefits, and lifetime savings have bnen scented and looted by the mining, oil, rubber, land, building and irrigation pirates. "Sucker" lists, running from 10,000 to 250,000 names, have been peddled at one to 25 cents a name, according to quality.

It is true that exposure has rubbed the bloom off this game. Over sixty such frauds have been stamped out by Uncle Sam. Access to the mails and to advertising columns is now less easy and more dangerous. The public itself is less ignorantly gullible.

But the postal raid can come only after much of the damage is done. The ounce of prevention must be furnished by the states that in the past have let their sovereign chartering powers to be so abused. Theft or misuse of the people's money by banks, insurance companies, etc., is guarded against; so should it be with these other, generically less dependable, creatures of the state The stable door should be locked in time.

It is from this viewpoint that the newly convened legislature of Massacnusetts has been officially asked to consider such a statute remedy where none exists. No definite statistics are now available as to past plunderings in the frugal Bay State; but legislative inquiry supplemented by promised federal data, may fairly disclose the need of action that is believed by local investment authorites to exist.

At the recent convention of state bank commissioners in New Orleans the Kansas experiment aroused deep interest. As yet, the vultures need merely fly across state lines; were joint and uniform state policy adopted, broadly following the Kansas example, they could land nowhere. The sole criticism might be of the establishment of forty-eight dictators as to what "promised a fair return," should the full measure of Kansas stringency be accepted.

Were the states, however, to check, by publicity and supervision, the snatchings of these financial harpies, more than the salvage of an immense sum would follow. It would hasten the extinction of the credulous "get-rich-quick" belief in impossible income returns; and it would largely recruit the twin armies of savings depositors and of small stockholders in legitimate corporations.

It is a notorious fact that for years every city, town and hamlet in every state of the Union, has been infested with promoters and vendors of the shares of fake mining schemes and other fraudulent devices whereby vast sums of money have been drawn from unsuspecting and unsophisticated individuals of all classes, trades and professions, whose avarice or cupidity ever renders them an easy prey to the wiles of unscrupulous tricksters and "promotion thieves."

Boston, for many years having enjoyed the distinction of possessing the greatest market in the world for copper mine shares, it is but natural that the speculative fever which had led to the enrichment of so many of her prominent citizens, should permeate and finally infect the industrial and moral fabrics of the entire country. Their earlier investments, which were chiefly confined to the great copper mines of the Lake Superior region, proved to be immensely profitable; but it soon came to pass that there were not enough REAL MINES to provide investment opportunity for the

numerous small hoards of her thrifty and progressive citizens, who began to look upon the meagre increment derivable from the factory or farm as entirely too tardy to meet the requirements of a constantly expanding ambition.

At first, their appetites were appeased with small and carefully selected packages of beautifully gilded and embossed paper, labeled certificates of shares in the "Great Eureka," "Last Chance" or "Bunker Hill" copper, gold and silver mines.

Of course, all mining shares looked alike to a people who were willing and eager to be made rich at the expense of the accommodating fakir, who seemed ever anxious to share his bounty at ridiculously low prices, so that there was always impatient haste to load up with the precious documents lest the supply should become exhausted before the constantly increasing demands could be satisfied. But to the bewildering astonishment of all, the sporadic adventure of the pioneer solicitor proved to be the advance courier of an army of "refined swindlers," each bearing bundles or bales of title deeds to a share in the "latest discovery," which always exceeded in richness and value all that preceded it. Finally, when all of the wants of the people had been supplied with these gilded evidences of wealth, in exchange for their surplus hoards, and they had sat down to await the coming of promised "dividends," NO DIVIDENDS came. Then it was that the "cost of living" arose to insuperable heights. But this was unimportant, because there were but few who could supply the price, had it remained ever so low. Then they cursed the "rich" and the frugal and thought "the thoughts of socialism and anarchy"—and thus you find them today. However, it now seems apparent, in the light of the News Bureau's comment, as quoted above, that in their sane moments, the people of Boston and of Massachusetts have determined to forstall a recurrence of the swindles that absorbed their substance and paralyzed the vital energies and industry of the state, by adopting the "Blue Sky law" of Kansas. Let us hope that the good resolution may not be forsaken and that every other state in the Union will "go and do likewise."

Such a law, had it been in force in this State ten years ago, would have saved the people of Utah MORE THAN TEN MILLIONS OF DOLLARS. And above all and of infinitely more value than preserved wealth—it would have prevented the deplorable degeneration of moral, mental and industrial energy which now glares from the sunken eyes of the thousands of victims of the ravages of accursed greed, fit and forced companions of socialism and anarchy.

Remembering the "Newhouse Mines" and the hundreds of other swindles of less magnitude but equal perfidy, perhaps our own Utah Legislature, when it shall again meet, will follow in the footsteps of our sister, Kansas, and preserve our people from the plundering schemes of these rapacious rogues.

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"BAD LUCK" GUGGENHEIMS

At the risk of receiving another peremptory "stop" order from some of the Guggenheim offices, Mines and Methods goes back to the files of the Salt Lake Tribune of October 10, 1908, for the following recital of Guggenheim bad luck. It will be noted that it serves to emphasize all that Mines and Methods said on the subject in last month's issue.

Some unfortunate investments of the Guggenheim interests in the mining line are just coming to light and explain in a measure why there has been such a housecleaning in the field forces, for the purchase of these properties was largely upon the recommendation of the highest paid mining engineering talent in the country, says the Boston News Bureau.

The Guggenheim Exploration company which is the principal mine owner of the Guggenheim outfit, has expended a total of $27,000,000 in acquiring properties within a comparatively few years.

One of the leading mining assets of the company was the property at Valerdena, Mexico. This was a silver-lead group, and was operated privately for years by Barton Sewell and associates, known as the old American Smelting and Refining crowd. The property produced between $8,000,000 and $10,000,000 from the old silver-lead ground from carbonate ores. Then no zinc had appeared in the ores and smelting costs were exceedingly low, and it was possible at that time to derive excessively large profits in treatment of custom ores. The Sewell interests sold the properties to the Guggenheims for $6,000,000, and they expended $1,000,000 in a new furnace plant and $400,000 on a new power plant. At the same time they purchased a copper property sixteen miles distant, and built a railroad to connect it with the Valerdena plant, so that the total investment at this point amounted to not far from $10,000,000.

Soon after the Guggenheim control, however, arsenic came in the ores, and operating conditions changed so that it is now said there has not been a dollar of profit derived to date on this investment. At the copper mine they went down 600 feet and found that the ore is practically exhausted, running at the lower levels but 1¾ per cent copper. Here is a $10,000,000 investment which could probably not be resold for over one-tenth of the cost. Valerdena is now a fighting word in the Guggenheim offices.

A second pronounced Guggenheim failure was a silver-lead property near Silverton, Colo., for which $2,500,000 was paid for the mine and an additional $750,000 expended in a new mill and equipment only to discover when the mill was ready that the mine was practically out of ore.

The Guggenheims likewise have a $7,000,000 investment in the Yukon, but the public was given an opportunity to help shoulder this burden. The selling of the shares was given to Lawson who was given an option upon 700,000 shares at $5 per share. The Yukon flotation some people call it by a harsher name resulted in 400,000 shares of the company being distributed to the public at from $6 to $8 a share. The distributor got his stock for $5 per share net, but as he had previous to the public offering distributed 200,000 shares among a favored few at 5½, he was obliged to take this stock back in the open market from $6 to $8, so that the net Lawson profit was [illegible] of a point on the [illegible] shares, or $270,000. The Guggenheims paid the advertising [illegible] of about $[illegible], and received an acknowledgement in the shape of an immense bunch of Lawson pinks sent to the Mauretania when Daniel Guggenheim sailed for Europe shortly after the Yukon flotation.

Another chapter could be written of the Guggenheim investment for the American Smelting Securities company of between $[illegible] and $10,000,000 in the three smelting plants on the Pacific coast. These included the Tacoma plant, for which $4,000,000 was paid, or many times the price at which the same plant had been offered to other interests six months previous to the time the Guggenheims purchased it. The Selby plant on San Francisco bay cost almost as much as the Tacoma plant. It is not now productive of earnings, because it it shut down tight, the agricultural interests having secured a permanent injunction against its operations because of the smelter fumes.

A third was the San Bruno plant, which was to have been built on San Francisco bay at a cost of $7,000,000, but was abandoned after the expenditure of $1,500,000 because of court injunctions from the agricultural interests.

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Elsewhere in this issue will be found an article dealing with the financial methods of the Guggenheims which is reproduced from the January 6 issue of Collier's Weekly. It describes how the family of "smeltermen" worked the public in Federal Mining and Smelting and gives an intimation of what is likely to happen if things work out right in the Braden Copper scheme. The article is a good companion story to that published in the December issue of Mines and Methods, wherein it was shown how the famous family was beginning to feel the effects of drifting on to the shoals of greed and avarice where they had been steered by sublime faith in their own infallibility and advice of their engineers. They had used the public's millions to make millions for themselves and they hoped to gather a much greater harvest without letting the public in. When their predicament finally dawned upon them, it was too late to again secure a public following. The article from Collier's gives one of the reasons why. Mines and Methods expects to offer others in the near future.

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The cut in the dividend of the Yukon Gold Company's dividend—from 2 per cent to 1½ per cent—is explained away by Mr. S. R. Guggenheim, who attributes the reduction to "the extraordinarily dull season prevailing in different parts of the world," and to the fact that two new dredges were not finished in time to be of much use. Glittering generalities don't go far towards soothing disappointed shareholders.—Canadian Mining Journal.

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Crib coffer-dams can sometimes be made by building a crib and sinking it. For shallow water the crib is sometimes made of uprights framed into caps and sills and covered on the outside with tongued and grooved planks.

As Others See Guggenheims

An Article From Collier's Weekly of January 6, by Garet Garrett, that Shows Up Federal Mining and Smelting Deal, and Which is Offered As a Companion Piece to Our Last Month's Story on "How the Guggenheims Were Goldbricked"

Collier's article, which is here reproduced in full, appears under the title and introductory heading of "Finance—the Division of Wealth. First of all people wish to be prosperous. After that they wish to reform each other. That is why an era of reform follows an era of great prosperity. Finance waits until the stomach has overcome the passion for reform and then begins all over again. Guggenheim Finance."

Though advertising space in Collier's be increasingly valuable, a little of it, free and unasked, may be spared to give wider circulation to the following paid notice inserted in the financial pages of New York newspapers:

> **To the Public:**
>
> Statements have been made in the public press to the effect that the Guggenheim interests have from time to time and recently sold or traded in the stock of the Federal Mining & Smelting Co.; the statement further being made that the recent decline in this stock was doubtless due to selling on the part of the Guggenheim interests. Such statements are without any foundation whatever, and are false. The undersigned desire their friends and the public in general to know that none of the Guggenheim brothers and no company in which they are interested has at any time bought or sold or owned or traded in any of the preferred or common stock of the Federal Mining & Smelting Co., except that a number of years ago the American Smelters Securities Co. purchased at private sale a portion of the common stock. This interest is approximately only one-sixth of the entire capital stock of the Federal. The Securities Company still owns every share of this stock, which they so purchased.
>
> The above statement indicates the only interest, either direct or indirect, which the Guggenheim brothers have had in either the preferred or common stock of the Federal Mining & Smelting Co.
>
> M. GUGGENHEIM'S SONS.

It is doubtless consoling to the holders of Federal Mining and Smelting Company stock to know that M. Guggenheim's Sons did not sell it to them. Federal Mining and Smelting in 1905 became known to Wall Street as a Guggenheim proposition on the announcement that the Guggenheims' American Smelting Securities Company, which is owned by the Guggenheims' American Smelting and Refining Company, had bought control of it. That the Guggenheims controlled the Federal Mining and Smelting Company was never denied until M. Guggenheim's Sons printed the notice above, saying that the American Smelters Securities Company's interest in it amounted to only one-sixth of the capital stock. Consider, therefore, the untrustworthy nature of such works of fiction as "The Manual of Statistics," "The Investor's Supplement of the Financial Chronicle," "Moody's Manual," and other books of reference, all of which have been saying until now that in 1905 control of the Federal Mining and Smelting Company was acquired by the American Smelters Securities Company.

Senator Simon Guggenheim, of Colorado, whose early retirement has been announced.

DID THE STOCKS SELL THEMSELVES?

However, Federal Mining and Smelting shares had a speculative vogue in Wall Street on the belief that the company was Guggenheimedly controlled, and they somehow got widely sold at high prices. In 1906 the common stock paid 14½ per cent and sold as high as 199. It has been declining ever since. In 1908 it paid no dividend; in 1909, 1½ per cent, and none since; it was quoted nominally at 10 bid and 17 asked on the day the Guggenheim's Sons' notice was printed. The preferred stock has paid its 7 per cent until now, but is not earning it; in two of the last three years it has not earned it. The preferred shares sold at 112⅞ in 1906; they were quoted around 40 on the day M. Guggenheim's Sons denied selling them.

The riddle is: How did Federal Mining and Smelting shares get sold to the persons who now hold them at a heart breaking loss? The shares must have sold themselves, of course. They sold themselves to credulous people not only in this country but, strangely enough, abroad, especially on the Continent, where the seven Messrs. Guggenheim are great travelers. If M. Guggenheim's Sons did not know in 1906 that Federal Mining and Smelting shares were either selling themselves or being sold on the Guggenheim name, they were the only seven men in the world of finance ignorant of it; and if they did not know that they were either selling themselves or being sold at a fantastic price value, then there is no accounting for the fact that M. Guggenheim's Sons have got rich in mining and smelting shares. So much for that point of view.

A PROBLEM IN THE MAKING.

There is a particular brand of finance, hardly any more popular in Wall Street than elsewhere, which may be called Guggenheim finance. A Guggenheim prospectus, apealing to private capitalists in the first instance, is a marvel of typographical beauty. It is done on heavy, calendered paper, expensive to the touch and suggestive to the imagination. For instance, one was recently issued on the Braden Copper Company, which has undertaken to develop the mineral resources of Chile, especially in copper. It is a perfect document, treating of history, climate, geology, sociology, costs, capitalization, profits, etc. Under the head of "Labor" one reads:

"The Chilean laborer is proud, independent, and improvident, but proves himself on the whole an excellent workman."

Mark the "but." In spite of being proud, indepenednt, and improvident, the Chilean on the whole proves himself worthy of hire. Continuing, one reads:

"Drink is his curse, and every effort is made to keep liquor out of the Braden Company's mines. . . . Labor is pretty thoroughly organized in the cities

of the republic, but not miners and common labor."

Obviously, the Chilean laborer, though better sober than drunk, is at his best unorganized. These are matters all very interesting to capital, invited to embark itself in a strange land. Directly one reads: "The Government of Chile is a republic, stable and reliable, and no fear is felt regarding the safety of investments made by foreigners." That is most reassuring. All of these remarks tend to the following culmination:

"The monetary system is such as to favor the foreign investor, for the reason that he pays for his labor in depreciated currency, and sells his product on the gold standard. A law has been passed putting Chile on the gold basis, and this was to be operative on January 1, 1911, but it has been considered to the advantage of the large landowners to avoid the change, and hence it has been again postponed—probably to be continued. The proposed change would bring the Chilean peso to 18d sterling in value, whereas now its value is below 11d."

Seldom does one see a problem of division in the making.

There it is.

Guggenheim finance undertakes to exploit the mineral resources of Chile, not for Chile, but for finance. It will make the Chilean laborer sober (though he be proud and independent), not for his own sake, but for finance; it will keep him unorganized if possible. Lastly, it will strike hands with the large landowners of Chile to postpone the gold standard, in order that finance and the large landowners together may buy labor for a peso worth twenty-two cents and sell its fruits in a peso worth thirty-six cents.

The reason finance can exact always the larger division is that it is heartlessly intelligent. The Chilean laborer is proud and independent, but too unintelligent to know what is happening to him.

One can imagine that after the Chilean laborer has been kept sober in spite of himself, for the sake of finance, he will, after many years, begin to think. He will have the effrontery to demand a larger division. He may protest against receiving his wage in a depreciated currency, while the product of his labor is sold on the gold standard. Then finance, with its large investments in copper mines, railroads, and prerogatives, ably supported by the landowners, will call the Chilean laborer a Socialist and lecture him sternly on the sacred rights of property. He will hesitate and perhaps forbear, but not for long. He will be dissatisfied with the slight concessions received, and demand yet more whereupon finance and the large landowners will warn him solemnly and with sorrow, and purely for his own good, that if he persists in the way he is going all progress will stop, all property will perish, and Chile will become a wilderness. Perkinses, Garys, and Littletons will rise up to tell him that they love him and are for him, only he is unreasonable. Above all else, he must be reasonable and patient. They will pension him, they will make him more comfortable, they will raise his wages, and they will allow him to buy shares in their business and thereby share in the profits of capital, but he must be fair and desist from his Socialistic attacks upon capital.

It will then be 2012, perhaps, and finance, both foreign and Chilean, will have had time to incorporate companies and sell the shares thereof to the people of Chile, so that when the Chilean laborer has become intelligent enough really to know what is happening to him, he will perceive that the resources of Chile have been bought back from finance at a very high valuation by the investors of Chile. They would be greatly damaged by radical and progressive legislation and are all against it. After that it will be a compromise of Things As They Might Be with Things As They Are, and then the average Chilean will learn how to lose money in things like Federal Mining and Smelting common stock.

OTHERS ALSO HAVE BEEN TAUGHT.

The people of Chile have much experience to digest before they will be as intelligent as some of the casual-minded people who bought Federal Mining and Smelting shares in 1905 and 1906 under the delusion that they were getting into a fine Guggenheim speculation, and who, now that those shares have only a nominal uncertain value, have the consolation of learning from whom they did not buy them.

The Chilean laborer does not know what is happening to him in Braden Copper. Neither does the holder of Federal Mining and Smelting know exactly what has happened to him.

The Braden Copper Company is owned by the Braden Copper Mines Company, which is a holding concern controlled by the Guggenheim interests, according to "Stevens' Copper Handbook." But if anything untoward should happen to Braden Copper it might develop that the "Stevens' Copper Handbook" was as much of a word of fiction as the other works of statistical reference which have called Federal Mining and Smelting a Guggenheim proposition. The holding company is a wonderful devise!

NORTHWEST MINING MEETING

There is to be an important gathering of mining men at Spokane next month, the purpose of which is to discuss many subjects of grave importance to the mining industry. Unlike a session of the American Mining Congress, in which everything but the real things which affect mining is annually accorded so much valuable time of the delegates, this Spokane meeting promises to consider and discuss phases of the present situation that are calculated to encourage the industry and its development along lines that will safeguard investment and secure a greater co-operation among those actually engaged in the business.

This meeting is to be held under the auspices of the Mining Men's Club of Spokane, at the Spokane hotel, on the 15th, 16th and 17th of next month (February), and promoters of the gathering are making preparations to take care of not less than 1,000 people from the western mining states and British Columbia. Some of the subjects that will receive particular consideration are: The mining laws; leasing vs. freehold; mining in forests; mining investments; water power development; metallurgical economies; wastes and losses; the prospector; the miner; the promoter; the mine manager; the investor; safeguards of mining investments; mining development, and other subjects which the spirit of the gathering are sure to suggest and force to the front.

Elaborate plans of entertainment are being arranged by the club and everybody engaged in the business of mining and kindred pursuits—and particularly through the Pacific Northwest—who may attend, are promised a profitable and enjoyable time. Railroad rates of one and one third for the round trip are being arranged for, the Club's announcement on this subject reading. "Pay full fare going, demanding certificate from agent, to be presented to the convention secretary." Utah ought to be well represented.

"What is this new commission form of government that has been inaugurated here since I left the state?" inquired a mining engineer who has just returned from a two years' trip to South America. His old Salt Lake friend disgustedly replied: "O, that's something that the cat dragged in."

EVOLUTION OF THE CALIFORNIA DREDGE

By AL H. MARTIN.

The first successful dredger in California went into commission March 1, 1898. The hull was eighty feet long, thirty feet wide, with a draft of seven feet. The rated steam horsepower was sixty-three. The latest designed goldships are 150 feet long by fifty-eight feet wide, with a depth of twelve feet. The rated electrical horsepower averages over 1070. The pioneer was equipped with 3½ cubic-foot buckets; the newcomers have fifteen cubic-foot buckets. The oldtime dredges were considered good workers if 1500 cubic cubic yards were handled daily; the latest design easily take care of 500 to 600 cubic yards per hour. And this remarkable advancement in efficiency has been scored in the brief space of thirteen years. As a result the California type of dredge is universally acknowledged the most efficient ever designed, and is employed alike in the tropics and in polar climes.

From the earliest days of gold mining in California, projects to recover auriferous gravel from the beds and bars of streams attracted attention. A rude contrivance was shipped to California in 1849, about a year after Marshall's discovery near Sutter's Fort, to excavate the golden wealth from the placers. Shipped from New York it successfully survived the long sea voyage and was placed on the Sacramento river. According to oldtime records it was unsuccessful from the start, and soon lay at the bottom of the kingly Sacramento. Following years recorded other attempts, but always failure rode the pilot. In New Zealand dredging made fair headway, and Montana was the first of American States to record the operation of a successful gold boat. In 1897 a dredge was constructed by the Risdon Iron Works of San Francisco and floated on the Yuba river. But this stream proved too turbulent for the newcomer and it was wrecked soon after going into commission.

SUCCESS OF RECENT BIRTH.

Thus far dredging history in California has been a record of unmilitated failures. Accordingly when W. P. Hammon, Thomas Couch, W. H. Christie and others arranged for the installation of a dredge at Oroville in 1899, many believed another folly had been launched. In the construction of the new gold-boat advantage was taken of the lessons gained in New Zealand and Montana practice, while not a few points of inestimable value were gathered from the ordinary gravel handling machines employed in canal building in the Eastern states. The pioneer, known as Couch No. 1, was of the single lift open-link bucket-elevator type, and after several modifications worked successfully.

The next great advance was recorded in 1901, when Indiana No. 1 went into action July 4th. This dredge was fashioned along entirely new lines and was the first of the celebrated California type. The hull was eighty-six feet long by thirty-five feet wide, with a draught of four and one-half feet. The buckets were close connected, in place of the usual open-connected type previously employed, and excavated gravel to a depth of thirty-five feet below the water line. There were seventy-nine buckets, each having a capacity of three and one-half cubic yards. The plate-girder digging ladder had a length of seventy-eight feet between centers. The washing screens were of the flat shaking-screen type. The drive was excentric, a twenty horsepower motor delivering energy. The gold tables were constructed of wood, with riffles and quicksilver trays. They were of the side-table type and had a total riffle area of 528 square feet. A forty horsepower motor delivered energy to the eight-inch centrifugal pump, which supplied water to the screens and tables. A sand-pump was also provided, receiving power from a thirty-horsepower motor.

Yuba No. 13, a Fifteen Cubic-foot Dredge—One of the Largest and Latest of California Gold-Boats.

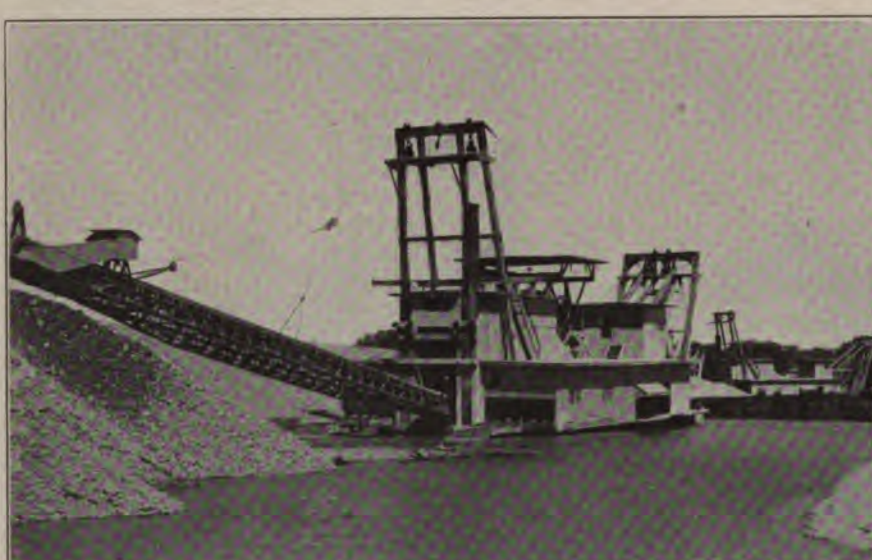
The design of this dredge embraced so many improvements and departures from accepted lines, that the owners, Cameron, Griffin & Perry, experienced the greatest difficulty in persuading a firm to manufacture the machinery. It must be remembered that dredging in California was then in its infancy, and the ideas of men considered to possess little experience were not hailed with particular delight by manufacturers of dredge machinery. But the Bucyrus company of South Milwaukee, Wis., was not lacking in the spirit of enterprise, and undertook the production of desired equipment. The new dredge proved remarkably successful, and all the later types of California gold boats have been modelled along the lines of Indiana No. 1.

IMPROVEMENT RAPIDLY DEVELOPS.

The next important step was introduced on Folsom No. 4 dredge, when double-bank tables were installed to treat a larger quantity of gravel, thereby largely increasing the profit-earning abilities of the dredge. This boat was of the thirteen cubic foot bucket type, and was one of the first of the new type of large dredges to be designed. The hull was naturally heavier, and the massive machinery required the installation of motors developing 415 horsepower. The double-bank gold-saving table arrangement was worked out by S. A. Martin-

dale, superintendent of the dredge, and the general idea of construction originated by R. G. Hanford, general manager of the Folsom Development Co.

The success attending the operation of No. 4 led to the construction of Folsom No. 5. This was the first gold dredge to be equipped with hydraulic monitors. The dredge was designed to operate on the Rebel Hill deposit, near Folsom, where conditions were particularly unfavorable. The deposit ranges from fifty to seventy-five feet in depth. The upper six to eight feet is partly cemented, and the following twenty-five to thirty feet is very compact. The lower deposit is easily handled. The monitors were designed to break down the upper strata of cemented gravel by undermining the bank with streams of water. The deposit had been considered as too difficult to dredge, but the monitors proved successful, their use further establishing the permanent value of the California dredge. It soon became manifest that the washing facilities of the boat were inadequate to handle the immense amount of material available, consequently revolving screens replaced the shaking screens, and longitudinal sluices were installed on each side of the dredge. The two monitors were stationed in the bow, each provided with three-inch nozzles. The gold-saving tables were constructed of steel, thus eliminating sand troubles, and dispensing with sand pumps.



A Thirteen Cubic-foot Dredge in the Yuba River Field.

FIRST DEEP DIGGER.

The first California dredges ever designed to excavate to a depth of sixty feet went into commission in the Yuba River field in 1904. The depth of the deposits in this district ranges from sixty to seventy feet, the great depth largely due to the deposition of immense quantities of debris on the native ground by hydraulic mining operations. The land is located in the Yuba River portion of the Sacramento valley, and for years the debris was washed down into the Yuba basin by the giants operating in the eastern foothills. The first boats installed had close-connected buckets of six cubic feet capacity, and required electrical machinery developing 230 horsepower. The construction of these dredges demonstrated the economical practicability of dredging to great depth; further augmenting the value of the gold boats.

Recent advances have been more along the increase of capacity, extending the life of the machinery and reducing operating costs per cubic yard. The latest dredges are equipped with fifteen cubic foot buckets, and easily handle from 350,000 to 450,000 cubic yards of gravel per month. The buckets number ninety, arranged in a close-connected line. Each bucket is made in three sections, consisting of bottom, hood and lip. The first is constructed of high-carbon steel, with an insert plate of manganese steel fitted under the back eye. The hood consists of half-inch steel plate, while the lip is formed of manganese steel. It is thirteen inches wide, and two and one-fourth inches thick at cutting edge. Sections are securely riveted, the entire bucket weighing about 3,700 pounds. The gold-saving tables are of the double-bank type, and with auxilliary trays, have a total area of approximately 7,600 square feet. These machines usually are digging gravel at a depth of fifty-five feet below water level. The dredge embodies all the best features of earlier designs, with numerous improvements suggested by long experience and skillful tests.

The latest departure is the construction of steel hulls, in place of the ordinary wooden ones. An all steel dredge is being constructed for the Natomas Consolidated of California, the largest dredging company in the world, and it is probable that future gold-boats will avoid the use of wood as much as possible. Not only does this result in a lighter hull and other advantages, but largely eliminates the danger of fire, a destroyer that has frequently visited the gold-boats.

ELECTRIC POWER IS UNIVERSAL.

The pioneer dredges of California were actuated by steam power. The first electrically operated boat was the Continental. This boat commenced operations in 1889, and was equipped with variable speed motors. This was also the first gold dredge to be equipped with close-connected buckets. This dredge was originally of the double-lift type, but was subsequently remodelled to conform to the ideas of the owners, Messrs. D. P. Cameron and F. W. Griffin. The excellent results obtained by the electrical equipment resulted in the gradual adoption of electric power by dredging companies throughout the State, and contributed largely to a more decided success in the industry.

At present electricity is furnished to the numerous dredging companies by several hydro-electric power companies. Power is generated in the high Sierras, where an abundance of water power is ever available, and transmitted to the dredges over high power transmission lines. In most instances the current is delivered at 2,000 volts to the dredges. In the newer type of dredges transformers are being eliminated, further safeguarding the gold-boats from danger of fire. Eliminating the transformer has been facilitated by the manufacture of motors to operate with 2,000 volts, several concerns producing machines as low as fifteen horsepower that may be thus directly operated. In numerous instances, when it has been necessary to employ transformers, these have been located on shore, rather than on the dredge. The power is usually brought aboard the dredge via insulated cables, of the submarine armored type.

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The sand used for filtering purposes should be clean quartz sand free from gravel and large particles and also free from excessive quantities of fine particles and dirt of every description. The presence of a small amount of fine material often aids the action of filter sand. For filtering river waters and any waters carrying carbonic acid, the filter sand should be free from lime, as otherwise the water will be hardened.

LEACHING APPLIED TO COPPER ORE*

Fourteenth Article Reviewings Results Accomplished, With Special Reference to Leaching Rock Without Mining

By W L. AUSTIN.†

It is immaterial whether or not a line be drawn between the extraction of copper from mine-waters which have been pumped, or allowed to flow from mines, in the ordinary course of events, and an operation comprising the artificial preparation of a copper deposit so as to facilitate oxidation and subsequent extraction of the metal. Both operations have been repeatedly carried out, and are practically identical in their nature, but the treatment of waters necessarily removed from mine-workings has been much the more common undertaking. The present article will deal primarily with the treatment of waters designedly passed through ore with a view to collecting the soluble copper salts therein contained, and the subsequent precipitation of the metal—in other words, with the artificial leaching of rock in place.

In a former article (Mines and Methods, Volume II, pages 153 and 187, there was described an experiment carried out upon a cupriferous deposit artificially prepared so that the ore had a chance to oxidize, water being let in afterwards to dissolve the soluble salts. It was explained in the said article how a deposit of porphyritic rock might be opened so as to expose a very large tonnage at comparatively small cost per ton of contained cupriferous material, and it is clear that once such a mine has been made ready for the water, the cost of producing copper will be confined to precipitation, with possibly the additional expense of pumping where it is necessary. Such a mine will yield copper for a long term of years from rock of a grade which it is not possible to mine under average conditions, and it will do this regardless of strikes, panics, or other disturbances of the usual kind.

When the experiment at Clifton was undertaken, it was not known to its projectors that there had been any previous work of a similar character; but since then a number of examples have been cited in the technical press, among which is one described by Philip Argall in Mining & Scientific Press of May 19th, 1906, pages 325-326.

Mr. Argall relates that at the Cronebane mines in Wicklow county, Ireland, the drainage was formerly run into a series of pits—each ten feet long, four feet wide, and eight feet deep. The sides of the pits were of masonry and the bottoms consisted of smooth flagstones. Rude wooden beams were laid across the pits upon which iron bars were placed to serve as precipitating metal. The iron bars were taken up frequently and the copper rubbed off them into the pits, so as to afford the waters better access to the iron. The bars were dissolved in about twelve months, when the iron was soft; but hard iron or steel were acted upon less rapidly.

When the iron in any particular pit had been sufficiently eaten away, the water was turned aside from that pit and the copper precipitate was shoveled out. One ton of iron (probably 2240 lb. was meant) is said to have produced 4424 lb. precipitate, and each ton of precipitate yielded 1792 lb. pure copper. On this basis one ton of iron was sufficient to produce 3539 lb. metallic copper, which is equivalent to a consumption of one pound of iron for each 1.6 lb. pure copper turned out. This copper brought in the market £10 more per ton than did copper resulting from ordinary ore-smelting operations. These figures, (presumably taken by Mr. Argall from the pages of the "Philosophical Transactions" whence the data was derived), do not agree with the usual statement that it reuqires from two to three pounds of iron to extract one pound of copper from mine waters. It is known, however, that with varying conditions the amount of iron consumed in the process of cementation differs widely, and as Mr. Argall had charge of the underground precipitation plant for a time, and therefore was familiar with the relative amounts of iron corroded and copper produced, it must be assumed that conditions at the Cronebane mine were out of the ordinary. The fact that pig-iron was used for precipitating purposes may have had something to do with the favorable result achieved, for the carbon present would form with both the iron and the copper galvanic couples, and it has been shown that such couples are very active in cementation. With proper apparatus, and the right adjustment of proportions of the elements composing the precipitant, it is not difficult to obtain results such as mentioned by Mr. Argall.

One of the improvements derived from experience at the Cronebane mine was settlement of the drainage in pits, only allowing the clear liquors to pass over the iron.

It was found in these precipitating operations that only a small quantity of the copper in solution was saved in the pits, and it is stated that these might be indefinitely extended without observing a sensible abatement in the copper content of the waters. The quantity of copper wasted at the property about the time referred to is thought to have been comparatively large, for in one stream alone the loss was estimated at 124,100 lb. per annum.

The handling of corrosive mine-waters has often been a problem with which those in charge of mines carrying sulphides in their ore have had to contend, the means employed at Wicklow to secure an efficient pumping apparatus are, therefore, of interest. Cornish pumps were used, the cast-iron water-columns of which were lined with quarter inch softwood staves. The flange-joints of the pipes were connected by gaskets of iron, one-and-a-half by quarter inch, around which was wrapped coarse flannel soaked in tar. The flannel and iron combined made a gasket about two inches thick, and in screwing up the pipe joints the tarred flannel was pressed out over the wood lining, securely sealing the iron pipe against contact with the acid waters, as well as making a tight joint between the pipes. Coarse tarred flannel, well painted with warm tar, was also wrapped around the pipes wherever these were exposed to dropping water. The suction pipes for these pumps consisted of logs of beach-wood, bored out to size, the bottoms being drilled with suitable holes to form strainers. The plungers and glands were made of bronze; the valves of copper and leather. These metals corroded, of course, and were about the only parts of the pumps which required frequent attention and occasional renewal.

By 1798 the copper content of the Cronebane mine drainage had fallen off materially, and low-grade pyritic ore was heap-roasted and subsequently

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leached to increase the amount of copper salts in the drainage waters. Then came a period in which operations were suspended.

The workings were reopened in 1874, and the effluent waters were then found to carry merely a trace of copper, though the mine had been closed for twenty years. Ocher had accumulated in the drainage adits almost to the roof, and the stopes above water, and the vein exposures were almost completely sealed with ocherous deposits. Apparently the copper had gone, leaving the sulphides so coated with ferruginous matter that the waters and air did not have access to them, which would account for the lack of soluble copper salts. As soon as the stopes, drifts, and working faces had been cleaned, oxidation proceeded as before, and the effluent waters again became rich in copper.

On account of difficulties arising with an adjoining property, it was no longer feasible to treat the waters in an outside plant, so an underground system of precipitation was inaugurated. This, Mr. Argall states, was a great success, owing in part to the higher temperature of the water, in part to freedom from sediment and almost entire absence of ocher.

Immediately below the gossan of the Cronebane vein there was found a rather soft clay filling which carried an abundance of granular pyrite, and various other copper minerals including sulphate. These deposits were leached in place, by first driving numerous small drifts through them, and then turning water into the overlying loose gossan. This innovation soon formed an important part of the mining work. The copper-bearing solutions were allowed to flow into the different levels between the outcrop and the lower adit, and being forced to traverse some old stopes and fillings, were finally collected at the lower adit where the copper was precipitated from the liquors on pig-iron.

As experience was gained in the work the following leaching cycle was evolved: First, there was allowed a period for oxidation of the sulphides, followed by a second period permitting the salts formed to go into solution. A third period succeeded, in which the ferric oxide, (which had a tendency to seal up the sulphides and prevent further oxidation), was removed. The ground was divided into sections, some of which were oxidizing while others were leaching, constituting the first two periods of the cycle. The third period was occupied in running short drifts across the vein and allowing these to cave. At times stoping was resorted to, to afford room for the settling vein-matter. Sometimes the vein-matter was caved through to the gossan workings, and the caved material was employed to fill lower stopes where in due course it was again subjected to the leaching process. The methods used are said to have proven entirely satisfactory.

The Connorree mine which adjoined the Cronebane is said to have produced prior to 1872, $75,000 worth of copper annually. It was worked for a year or two almost entirely for the cement-copper obtained from drainage, and all the water was pumped from a depth of 540 feet, using expensive coal for power. This mine was closed in 1880, and in 1884 it is stated that the stagnant mine-water was found to contain forty grains of copper to the gallon. Taking the gallon at ten pounds, forty Troy grains would be equivalent to 1.14 lb. copper per ton of 2,000 lb. of water, which is close to the amount observed in other cases where mine-water has been permitted undisturbed to take up soluble copper salts. At one time the ore of this mine was kernel-roasted, and the oxidized envelopes of the sulphide kernels were leached in the mine water.

A precipitating plant was also erected at the Ballygahan mine which is on the same lode-series, and this plant is said to have been in profitable operation for five or six years. The pumping was done in this case with water-power. Some analyses made of the waters before and after precipitation gave following results:

In 100,000 Parts.

	Before Precipitation.	After Precipitation.
Ferrous oxide	81.81	94.75
Ferric oxide	4.30	6.70
Cupric oxide	9.32	1.91
Sulphuric acid	634.26	642.34
Manganese oxide	2.30	2.50
Zinc oxide	1.20	1.80

A content of 9.32 parts of CuO in 100,000 is equivalent to 0.00932 per cent, which corresponds to 0.00744 per cent Cu (0.1488 lb Cu per 2000 lb. solution), an amount of metal which approximates the average that mine water in motion appears disposed to take up under normal conditions.

It is stated that the water issuing from the Butte mines contains an average of 0.0025 per cent copper, and that 5,000,000 lb. of the metal are recovered from them annually (Engineering and Mining Journal, Vol. LXXXV, page 99); but the conditions there are somewhat unusual. The Butte mines are very extensively opened and were very hot, so that the waters traveled long distances through old workings (some of which are on fire) and had every opportunity to take up soluble copper salts. The drainage at the Anaconda mine is allowed to run from level to level through drill-holes until the pumps are reached. These drill-holes choke up with sediment and basic ferric salts and require re-drilling from time to time. An analysis of the water from one of the large Butte mines, made some time ago, gave the following results:

(Specific Gravity of Water=1.005.)

	Grams Per Liter.	Per Cent.
Copper	0.1226	0.0122
Iron in suspension	0.1274	0.01267
Iron in solution	0.0672	0.0067
Arsenic	0.00264	0.00026
Antimony	0.00088	0.000088
Free acid	0.1400	0.0139
Prob. combination.		
Bluestone ($CuSO_4 5H_2O$)	0.4830	0.0481
Ferric oxide (Fe_2O_3)	0.1820	0.0181
Ferric sulphate [$Fe_2(SO_4)_3$]	0.2399	0.0239
Arsenic	Undetermined	
Antimony	Undetermined	
Sulphuric acid (H_2SO_4)	0.1400	0.0139

In September, 1906, the flow for the month from one of the largest groups of Butte mines averaged 0.02 per cent copper; in December of the same year the average for the month was 0.04 per cent on a flow of 470 gallons per minute. In January, 1907, the same waters carried 0.16 per cent—the highest record, due to fire in the mine—and in February of that year the average for the month was 0.07.

Another instance of leaching unoxidized copper-ore in place is mentioned by Mr. H. T. Durant in Engineering and Mining Journal, November 11th, 1911, page 928. The name of the mine is not given, but it is said to be situated "barely 300 miles from London," and it is stated that the operation is upon a working scale and has been carried on day in and day out for over sixty years. The deposit is referred to as being a vein, which in places exceeded one hundred feet in width but elsewhere was so narrow as to render working unprofitable.

The underground workings are said to resemble a rabbit-warren, and the fact that the mine is thoroughly honeycombed accounts to a large extent for the ease and rapidity with which much of the copper passes into sulphate form.

The property is drained by an adit the mouth of which is closed by a dam, the latter fitted with a sluice valve. The operations consist in pumping the mine full of water, practically to the collar of the old main shaft, and then opening the valve at the adit mouth and allowing the liquors to flow to the precipitating plant. The latter consists of a number of shallow, rough, stone-lined pits, arranged in parallel series for convenience in cleaning and distributing solutions. These pits are filled with scrap-iron.

After precipitation of the copper, the liquors containing the iron derived from the ore, together with that corroded in the precipitation pits, are passed through a number of pits similar to those already

mentioned. These latter pits are also arranged in parallel series but are larger than the ones employed for cementation: in them the bulk of the iron is deposited through aeration and oxidation, and a good, marketable ocher is produced. This material brings in the market from twenty to thirty shillings per ton, according to quality.

After flowing through the ocher pits the water is more or less freed from iron and when required may be pumped back to the mine to repeat the same cycle of operations. The liquors flow by gravity from the adit mouth through the precipitating pits, and then through the ocher ponds, power being used only for pumping back to the mine.

The mine is filled with water from two to four times per annum, varying with the seasons. Only one skilled man is employed on the work, assisted by two or three laborers, the number of the latter being increased when the copper precipitate and ocher are cleaned up. The application of the described method of leaching was facilitated by the contour of the country, and by the unsystematic methods of exploitation used by the old miners. The further fact that much of the ore was left in place, either on account of narrowness of vein, or grade, or both, and the existence of large blocks of complex sulphide-ore containing small quantities of copper, made it feasible to leach this copper-sulphide ore in place.

The net result from the operation since the inception of this method of treatment is said to be about two hundred tons of metallic copper annually, and during the same period from 1500 to 2000 tons of ocher are produced The whole equipment is represented to be extremely crude, and the ingenuity displayed in securing such good working results with the means at hand commands admiration.

According to Mr. Morton Webber (Engineering and Mining Journal, (April 8th, 1911, page 700), at Rio Tinto, in Spain, water is led into the mines under certain conditions. The ore is mined in large galleries, and the honeycombed part of the "vein" produced by the removed chambers offers a large surface exposed to the action of the air and moisture, which in turn brings about oxidation of the copper in the ore to sulphate and other forms. The cupreous liquors naturally gravitate to the bottom of the mine from where they are pumped to the surface. They are then led into precipitating pits similar to those employed for treating cupreous solutions obtained more rapidly from ore which has been heap-roasted. The copper derived from mine drainage is such an important item at Rio Tinto, that the magnitude of the rains during the wet season is said to materially affect the years' profits.

Another case mentioned by Mr. Webber is that of the famous old Parys mine at Anglesey. For a long time water was pumped out of the mine and led into pits which were lined with brick and contained scrap-iron. The iron was raked over from time to time, and gradually the old pots, kettles, meat tins, shovels, etc., passed into solution while the copper was precipitating. The iron was not lost for the waste liquors from the precipitating pits were drawn off into large pools where the ferruginous salts gradually passed to a higher state of oxidation, depositing ocher. The ponds were run dry and cleared out periodically.

In a more recent communication Mr. Webber (Engineering and Mining Journal, July 29th, 1911, page 197) calls attention to an interesting example of the solubility of copper minerals under natural conditions as recently observed in the lower workings of a mine belonging to the Transvaal Copper Mining Company, at Cumpas, in the State of Sonora.

In September, 1910, after five years or more of submergence, the lower workings of the said mine were pumped out and resampled. The result of this sampling disclosed the fact that there was apparently no commercial ore left in this particular part of the mine. Previous samplings on different occasions by two independent engineers had indicated an average of over two per cent copper in this same ore. It being assumed that the different samplings were all carefully done, and that the findings were correct, then it would appear that the copper had been leached out in the interim between the earlier and later samplings, which view received confirmation from the interesting fact that the silver content of the ore in question was found to be the same after as before submergence.

In a criticism upon any novelty attaching to the idea of leaching ore without previously mining it, Mr. Channing in a contribution to Engineering and Mining Journal, March 25th, 1911, page 601, states that at the Eureka mine, in the Ducktown District of Tennessee, copper was extracted from rock in place as early as 1850.

Mr. Channing is right in contesting on a broad basis novelty in the practice of leaching rock "in place;" but there may be different methods of accomplishing a given purpose, one of which may be new. Besides, it is sometimes advisable to provide precautions against patents being issued to other parties who may be inclined to take advantage of a situation thereby created. Furthermore, circumstances may arise where those financing an enterprise demand that patent-protection be sought and obtained if possible. In any event, the systematic preparation of a large mass of low-grade cupriferous rock for leaching in-place is not such a common occurrence as to wholly exclude the projectors of the enterprise from claim to some originality of idea.

Mr. Channing states that at the time to which he refers, mining at Ducktown was confined entirely to the so-called black-copper ore, which was a product of secondary enrichment, lying just under the gossan and just over the unaltered sulphide. In most of the mines this black copper was from six to twelve feet thick and often carried as much as fifty per cent copper. At the Eureka mine, however, and also at the adjoining Isabella property, the zone of black copper ore was not much over a foot in tickness, and it was soon discovered that it would not pay to mine it.

The Eureka was provided with a shaft and several hundred feet of drifts along the black copper zone, and a method was finally evolved which consisted in permitting the mine to fill with water, then, after the water had been allowed to work on the ore for about a month, to pump it out again. By this means, it is stated, the black-copper was pretty thoroughly dissolved, and the metal could be precip-

(Grams per 100 cc. solution.)

Names of shafts	Free Sulphuric Acid	Ferrous Iron	Ferric Iron	Total Iron	Copper	Chlorine	Iron precipitated in Bottle	Alkalinity Equival'nt in Sulphuric Acid	Percent copper	Lb Cop. per ton Water	REMARKS
Diabase......	0.261	0.0096	0.0031	0.0127	1.056	......	0.0048	......	0.1056	2.112	Strong green color to solution.
Old Ray	0.027	tr	.....	0.0021	......	......	......	......	.....	.....	....
Flux	0.1004	0.31	0.0990	0.4090	0.06	Pres.	......	......	0.006	0.12	Organic acid present.
Cittadini......	0.126	0.392	0.03	0.422	0.152	......	......	......	0.152	0.304	Solution greenish.
Man Tiger ...	0.134	0.395	0.032	0.427	0.253	0 072	0.0313	......	0.0253	0.506	Solution clear.
Pearl Handle..	0	0.1482	0.0072	0.1554	0.012	......	.....	0.0077	0.0012	0.024	Solution clear with brownish tinge.
Sharkey......	0 019	0.5687	0.0397	0.6084	0.8378	......	......	......	0.08378	1.6756	Solution blue-green.
Cellom........	0.046	0.1682	0.0335	0.1917	0.476	......	0.01	......	0.0476	0.952	Solution with strong green color.
Rector.......	0	0.0254	0.0176	0.043	tr	......	.....	0.047	tr	tr	Solution dark with disagreeable odor.
Hecla........	0	0.2249	0.0030	0.2279	0.0646	......	0.002	0.057	0.00646	0.1292	Solution colorless.
Mathias & Hall.	0	0.0098	0.0155	0.0253	0.0474	......	.....	0.0067	0.00474	0.0948	Solution brownish.

itated from the solution by scrap-iron in the usual way.

When the mine was opened later it was found that the primary sulphides carried less than one per cent copper, which accounted for the thin deposit (one foot) of black ore referred to. The vein, or deposit, on the Eureka was wide, averaging at least 250 feet, and the gossan (aggregating approximately 500,000 tons) has all been mined, shipped, and smelted for iron.

The leaching power of ground-waters upon certain types of ore-deposits is illustrated by the analyses given in the table below. The analyses were made from waters taken from a number of old shafts on the Ray property in Arizona, and were furnished the writer by Mr. Philip Wiseman of Los Angeles.

The average copper content of these waters is 0.02689 per cent, which is ten times the average of the flow from the Butte mines as given in the Engineering and Mining Journal quoted from above.

At Bisbee, Arizona, 300 gallons of mine-water are pumped per minute from the Czar shaft, (Engineering and Mining Journal, October 31st, 1908, page 854), which is said to contain an average of ten grains of copper per gallon. The copper content of the water is, therefore, 0.0171 per cent. This water is passed over scrap-iron in a precipitating plant, the saving being in excess of ninety per cent. The precipitate shipped contains forty per cent moisture: the dried sample assays, copper 35%, silica 6%, iron 17%, aluminum 13% and sulphur 1.5%.

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UTAH'S GOLD-SILVER OUTPUT

Increased production was made in all metals except zinc in Utah in 1911 according to V. C. Heikes, of the United States Geological Survey. The gold output was greater owing to the larger quantity of silicious ores mined in the Tintic district. Also of importance were the increases made at Bingham in the mining of low-grade copper ores, which carry only a few cents per ton in gold, but the aggregate of which is large. The total output of gold from the producing gold mines of Utah—the Mercur, Sevier, Susannah and Jennie, was less than in 1910. No new developments in deep mines were made that would tend to increase the future gold output, except in the Newton district, Beaver county, where some high-grade ore was encountered in rhyolitic rock, and at a property in Wayne county, which was equipped with a stamp mill. The placers on Green River yielded an increased quantity of gold. A dredge of the suction type with amalgamators was erected on Pahreah River, in Kane county, and is said to be operating and producing gold.

Silver production increased owing to the large tonnage of argentiferous lead concentrates and ore shipped, especially from Park City, where the output was greater than in any one of the last four years. In the Tintic district the yield of silver decreased owing to the reduced tonnage of lead ores, but this decrease was met by the increase in the mining of other ores, so that the total silver yield was not much less than in former years. According to early figures Utah ranked first in output of silver in 1911.

Fortunately for Utah mine operators, the facilities for treating ore and concentrates were ideal in 1911, and the lead-mine owners especially were provided with the best competitive smelting market that they have had for years. On the other hand, complaints were made by the lead smelters as to the small ore tonnage shipped, as only 40 to 65 per cent of their maximum capacity was in operation. Silver production under these conditions, of course, increased as every available ton of lead ore was mined and shipped. A part of this ore awaits the completion of the lead furnaces at Tooele. Nearly 7,000,000 tons of ore was mined in 1911 in Utah. Of this record-breaking output, about 5,850,000 tons was credited to the mines of the Bingham district. The greater part of this tonnage was low-grade copper-bearing porphyry ore mined from the Utah Copper and Ohio properties, and lead and copper ore from the mines of the United States Co. The two last-named companies increased their shipments of ore to such an extent that the roasting capacity of the lead smelters was overtaxed and they refused ores of high sulphur content in excess of contract agreements.

Beaver county mines yielded about 258,000 tons of ore, of which about 30,000 tons was crude ore and concentrates shipped from the Frisco, Star, and Newton districts. The new equipment at the Cactus mill was successful. The mill of the Horn Silver mine was closed, as a favorable contract was offered by the smelters. The Sheep Rock and Rob Roy mines near Beaver City, and the Susannah mine and part of the old dump of the Century mine, in Box Elder county, yielded gold bullion. Mines in Juab county produced approximately 246,000 tons of ore, of which the Centennial-Eureka mine, a gold-silver-copper producer, yielded about 117,000 tons, and the Iron Blossom about 60,000 tons of siliceous and lead ores. Other properties in Juab county from which shipments were increased are the Black Jack, Bullion Beck, Gemini, Golden Chain, Grand Central, May Day, Mammoth, Opohongo, Uncle Sam and Yankee. In the Fish Springs district the Utah mine produced rich silver-lead ore. The Park City mines were productive of about 300,000 tons of ore, against 215,339 tons in 1910. Part of this ore was concentrated, making about 65,000 tons of lead concentrates and 12,000 tons of zinc concentrates, both averaging well in silver. The crude ore shipped to smelters in 1911 contained silver and lead, and aggregated over 42,0000 tons, against 30,140 tons in 1910. From the Ophir, Rush Valley, and North Tintic districts, in Tooele county, 30,738 tons of lead ores were shipped from the Hidden Treasure, Cliff, and Honorine mines, and lead, zinc, and zinc-lead ores from the Scranton mines. In the Camp Floyd district, at Mercur, 250,000 tons of low-grade gold ore was treated by the cyanide process, yielding about $551,000 in gold.

According to preliminary figures compiled by the Director of the Mint, Utah produced in 1911, $4,709,747 in gold and 12,679,633 fine ounces of silver, valued at $6,973,798, against $4,312,700 in gold and 10,445,900 ounces of silver valued at $5,640,800, in 1910.

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EVERYBODY'S EXPERT

O. R. Henney, who is a guest at the Linden hotel, this city, and booked to make this his headquarters for some time to come, is making a business of gathering reliable data concerning mines and prospects in this particular region. "My special mission," said Mr. Henney a few days ago, "is to secure information for small investors who have neither the time or means to get a correct idea of the value of their investments or speculations. I have had eleven years' experience in Colorado, New Mexico, Arizona, Southern Nevada and California, in addition to some time spent in Mexico and Honduras. Now I am gathering information and data for clients interested in the surrounding territory." If you want Henney's services, write to him at the address given above.

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Geologists, sent to prospect in the Congo Free State the 970,000 square miles of land conceded as a mineral grant five years ago to a company in which Thomas F. Ryan is heavily interested, have reported that they have found large amounts of gold, iron, petroleum and diamonds. The finding of diamonds was a surprise. Two hundred and forty were found near Kambambay and some of them are on the way to America now.

MIAMI DISTRICT REVIEWED

Owing to the merger or consolidation of the Inspiration and Live Oak companies' properties in the Miami district, Arizona, which is now practically completed, together with the prospect that sooner or later the Miami and Keystone will be included, the following article descriptive of these properties and the conditions surrounding them, by so competent and impartial a writer as W. R. Ingalls, editor of the Engineering and Mining Journal, will be of keen interest to Mines and Methods readers at the present time. The article is taken from the Engineering and Mining Journal of the 13th instant, and in full reads as follows:

Four mines at Miami, Ariz., have been opened on the great deposit of disseminated copper ore that exists in that district. From east to west these are the Miami, Inspiration, Keystone and Live Oak. They are opened upon what is really the same orebody, although there are certain breaks in it, to which I shall refer. The ore is a schist mineralized chiefly with chalcocite. Up to the present time a total of about 66,000,000 tons of ore is claimed to have been developed in the four mines above mentioned.

THE MIAMI MINE.

The only producer of the Miami district at present is the Miami Copper Co., which is now mining and milling from 2,400 to 2,500 tons of ore per day. This is being done with five sections of the mill. When the sixth section is completed and the mill is thoroughly tuned up, its capacity will undoubtedly be about 3,000 tons per day. The sixth section will probably be ready for operation by the end of January, 1912. The foundations are ready for two more sections (each of 750 tons capacity), but there is no immediate plan of building upon them. Eventually, one or both of them will probably be completed for the milling of the ore of neighboring companies. With milling capacity for 3,000 tons per day, the Miami itself is adequately supplied, in view of its present ore development.

According to the last official report of this company, it has developed 18,000,000 tons of ore averaging 2.58 per cent copper. Since then no attempt to increase the reserves has been made. It would not be good policy to do so. It may be said, however, that the management expects to add to the reserves both with depth and laterally, and there seems to be sound reasons for such an expectation, especially as to the extension of payable ore to greater depth than yet estimated.

METHOD OF DEVELOPMENT.

The Miami development has been chiefly by blocking out the ore in the old-fashioned way. In doing this, about 100,000 ft. of drifts, raises, etc., have been run. No other of the "porphyry" mines has done anything like so much of such work in proportion to the volume of orebody. While it is pleasant to learn at other mines that stoping is checking closely with the estimates based on drilling, nevertheless a superior confidence is bound to be felt in development that has put the ore actually in sight. Above the 420-ft. level the Miami has about 8,000,000 tons of ore, a large part of which has already been prepared for mining. If anything, the management has anticipated the requirements of mining too far ahead; in other words, has expended too much money in development in advance of mining. This, however, will all come back in course of time.

The Miami orebody occurs in the form of a submerged mountain with twin peaks. The highest horizontal section shows only two small patches of ore—the two apexes. Succeeding sections show them to be of increased size, until finally they merge together in one great area of ore. The extraction of this orebody has been begun at the top, and at present is being done chiefly by square-setting, the objects being to take out the ore cleanly below the capping and form a thick mat of timber between the capping and the ore in order to keep them separate when the caving is fairly in progress. This system of mining is designed to extract the maximum percentage of ore without dilution, and is performed at a relatively high expense for timber, the expense for which at present comes to nearly 25 per cent of the total cost of mining. The mining of the Miami orebody is, in fact, being done at present under the most unfavorable conditions. Not only must the timber mat be formed, but also all prongs and tongues of ore extending into the capping must be extracted now, if ever. This involves a good deal of relatively costly hand mining, which will disappear when the extraction by caving is fairly in progress.

Surface Plant of the Miami Copper Company.

COST OF MINING.

In spite of the relatively unfavorable conditions of beginning the extraction of ore and the operation at only partial (about 60 per cent) capacity, the cost of mining has been lower than was originally estimated having been only about $1.20 per ton (of which about 30 cents is for timber), and there is no doubt whatever that this will be further reduced as operations come into full swing. It is to be remarked that the method of mining introduced in the Miami mine is designed to secure a high percentage of ore extraction, but what this will be has not yet been determined. Of course, it is possible in such mines to extract nearly 100 per cent of the ore, but it may be less profitable to do so than to stop short of such arithmetical perfection.

I will not undertake to describe the mining methods or equipment, which doubtless will be done later by the engineers who are responsible for them. For the present it is sufficient to say that Messrs. Channing, Gottsberger and Lawton have done highly creditable work, both in their planning and in their exe-

cution. The mine is so laid out that the ore is delivered through a main gallery, at present on the 420-ft. level, to a large shaft of great capacity through which it is hoisted by compressed air engines and delivered directly to the mill.

THE MIAMI MILL.

The Miami system differs from that of most of the porphyry mines, in that the mill is built right by the shaft, the water being pumped to it, instead of carrying the ore a more or less distance to the water. The decision between carrying the ore to water and water to the ore depends, of course, upon the comparative expense. At Miani the cost of water is about 6 cents per ton of ore. Such a low figure is attainable only when there is economical use of water.

In laying out the Miami mill, so excellent advantage was taken of a rather difficult and forbidding topography that the result leaves but little to be desired. The ore passes from the bins in the headframe of the shaft to the crushing house, and thence by belt conveyor to the mill proper. In the latter the first crushing is done by Burch rolls, which are followed in some sections by chile mills and in others by Hardinge mills. Originally, one section was equipped with rigid rolls, but although they gave the commonly desired granularity of product, in this case they failed to release fully the mineral, for which crushing to pass a 60-mesh screen seems to be necessary. As between the chile and Hardinge mills, it is rather strongly indicated that the latter will become the favorite.

The pulp is washed on Deister tables. The concentrates run through a tunnel to bins at the foot of the hill. The tailings go to a dewatering plant below the mill, which operates with marvelous efficiency. The total quantity of water required in milling a ton of ore is nine tons; the quantity of new water supplied is only two tons. The dewatered tailings are discharged into a commodious pond formed by a dam across a small ravine. As discharged into it their copper content is not high.

The ore delivered to the mill has been averaging about 2.5 per cent copper. The ratio of concentration has been 20:1 to 22:1, the concentrates assaying about 40 per cent copper. The extraction of copper has been about 75 per cent. In spite of the fine grinding to which the ore must be subjected, the loss of copper in slime is low. It is expected that the extraction in milling will eventually be raised to nearly 80 per cent. Considering the character of the ore and the excellence of the mill equipment, it is not improbable that such a remarkably high extraction will eventually be obtained when it has been learned how to operate the mill to the best advantage.

DESIGN AND CONSTRUCTION.

In the matters of design and building, the Miami mill is at the present time the last word in mill construction. There is no other concentrating mill of which I am aware that has so much purely structural excellence, so much floor space, so much lighting (both by day and by night-, so unobstructing a belt, shafting and launder plan and so much cleanliness. Here is a mill in which a visitor may go in his best clothes without fear of harming them.

Some criticisms have been directed toward the Miami engineers upon the ground of their apparent extravagance. I use the word "apparent" advisedly, the cost of the Miami mill per ton of annual capacity not having been excessive even when compared to other mills of decidedly inferior construction. But even if some apparently unnecessary outlays were made in the Miami mill, I am, nevertheless, of the opiinon that the money was extremely well spent. An addition of 25 cents per ton of annual capacity in the first cost, let us say, is very quickly offset by the ability to extract an extra percentage of copper from the ore. This has already been demonstrated in the phenomenally high extraction that has already been made in the Miami mill. The provision of a commodious, well constructed and well kept plant improves the morale of the men. Given such a plant they are likely to adapt themselves to its conception, whereas if put to work in an inconvenient sloppy plant, they are more likely to absorb the spirit of the engineers and themselves become careless.

The Miami mill has been compared to a magnificent mansion, fitted up with appropriate furniture. If, at any time, it may be desirable, it is an easy matter to change the furniture. In the Miami mill the furniture is the machinery and special apparatus. If, at any time, it may be necessary to change the machinery because of alterations in the milling qualities of the ore, or because improvements in the art have led to the development of better forms of machinery, adaptation to either condition is easy in the Miami mill, because of the foresight and broad conception of its engineers. From this point of view the elaborate construction of this mill is not only a direct means of immediately making more money, but also is an insurance against adverse alterations in conditions in the future.

INSPIRATION COPPER CO.

Going westward from the Miami, the orebody spreads out, or at least becomes less thick than it is in the Miami, and deflects to the southwest, the general trend being shown in the accompanying map. The orebody is faulted in the Inspiration property, as may be surmised from the peculiar shape shown by the map. Toward the Keystone line the orebody is broken by a fault that has thrown it down in the Inspiration territory and produced an area on the dip of the fault wherein no ore is to be expected. Another fault is known to exist in the neighborhood of the line between the Keystone and Live Oak property. Besides a vertical dislocation at this place, there also appears to have been a heave of the Live Oak orebody to the northwest. The faulting of this district and perhaps other geological conditions have not yet been adequately studied.

Up to the present time the work of the Inspiration Copper Co. has been confined chiefly to prospecting development, which has been both by churn drilling and by underground work, chiefly the former. A good deal of underground work has been done, but nowhere near to the same extent as was done by the Miami Copper Company.

The developments in the Inspiration have disclosed the existence of an orebody of about 120 ft. average thickness, with a maximum length of about 3,800 ft. and maximum width of about 1,600 ft. It is estimated that this orebody contains about 30,000,000 tons of ore, averaging 1.95 per cent copper.

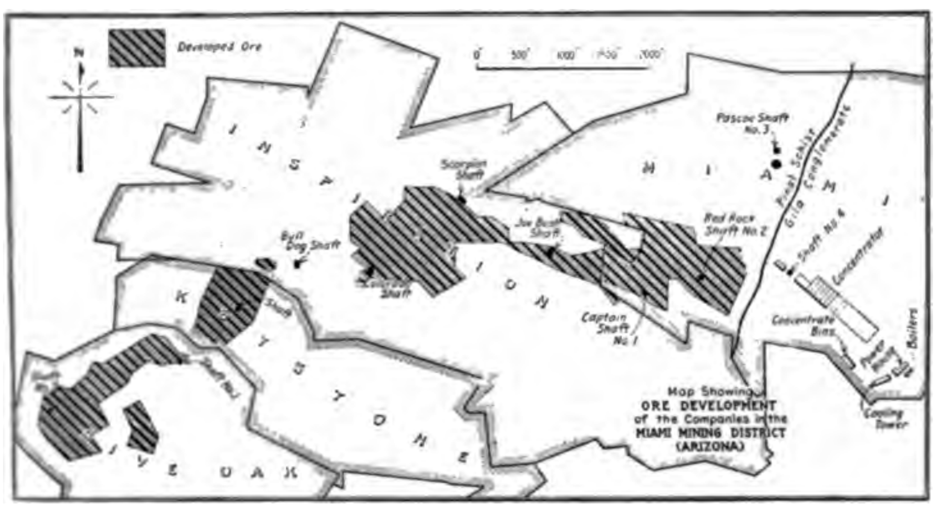
The Inspiration is undoubtedly a very valuable mine, but in comparison with the Miami it is at the disadvantage of a materially lower grade of ore. It follows from this that if the extraction of the ore were to be conducted by the same methods as in the Miami mine, the cost per pound of copper product would be very materially higher. It is likely, however, that the mining of the Inspiration ore will be done by a cheaper method of caving, perhaps by suitable modifications of the methods employed at Bingham and at Ray. This will afford much cheaper ore at the expense of a lower percentage of extraction. I am, however, favorably disposed toward such systems when introduced under suitable conditions, and believe it to be not unreasonable to expect that the extraction of ore may be as high as 83 per cent. Any such result would, of course, go a long way toward offsetting the disadvantage of the lower grade ore. However, it is not to be expected, not even under the most favorable combination of circumstances, that Inspiration can produce a pound of copper so cheaply as Miami.

A considerable part of the Inspiration orebody is so situated that it can be extracted through an adit level. Just what use will be made of that entry, and, indeed, just what will be the plan for the mining and milling of the Inspiration ore, has not yet, so far as I am aware, been finally decided.

THE KEYSTONE PROPERTY.

Adjoining the Inspiration on the west is the property of the New Keystone Copper Co., which is an interest of the General Development Co. The surface of the country is noteworthy at this place for a remarkable coloration of the country rock by silicate of copper. Unfortunately the copper content of the surface exposures is not sufficiently high to be commercially valuable. The lines of the Keystone property proved to have been laid out in such a way that this company did not secure a large portion of the orebody.

As in the case of the Miami, the development of the Keystone mine has been chiefly by drifts, winzes and raises. It is only recently that any drilling has been done. The underground work was laid out in a thoroughly systematic way, upon two levels, viz: The 150-ft. and 250-ft. This work has disclosed an orebody about 400 ft. in width and 70 ft. in thickness. At the date of the last annual report of the company, last summer, it was estimated that 2,000,000 tons of ore, averaging 2.25 per cent coper, had been substantially prepared for mining. This ore is in the part of the property adjacent to the Inspiration. In going toward the west the Keystone ore dips downward, wherefore the drifts of the 150-ft level and then of the 250 ft. level pass out of the ore into the oxidized capping.



A winze put down from the 250 ft. level to the west of the line beyond which the ore had dipped below that level rediscovered the ore and gave a more correct understanding of its position than was possessed when the earlier work was done on the 250-ft. level. Inasmuch as the sinking of winzes is relatively expensive, recent exploratory work has been confined to putting down churn-drill holes from the surface at the corners of 100 ft. blocks. These have been proving the western continuation of the orebody, but its amount and grade have not yet been estimated. Near the Live Oak line the fault, previously mentioned, may cut off some of the ore, but probably to no great extent. It is reasonably to be expected that about 1,500,000 tons of ore will be added to the Keystone reserves, making a total of about 3,500,000, which may be somewhat increased if the basis of estimating be reduced to 2 per cent copper.

The Keystone mine is favorably situated for operation. The ore seems to grade off into the capping and a high percentage of extraction can perhaps advisably be effected by taking in a litt'e of the capping at the expense of a slight diminishing of the average copper content of the product. The shaft is adequate in size for the extraction of 350-000 tons of ore per annum and from the preesnt outlook the whole orebody can be commanded from the 350-ft. level. The Keystone mine has not sufficient ore to justify the erection of a modern mill, and its ore will probably be treated in a section of the Miami mill that may be added for this purpose. The Miami mill is in view from the Keystone shaft, about 8,000 ft. distant and about 350 ft. lower, wherefore the ore may easily be delivered by aerial tramway, right of-way for which over the Inspiration ground is possessed. The Keystone mine is under the same management as the Miami.

LIVE OAK.

The Live Oak is the most recently developed of the mines of the Miami district, and the work in it up to date has been chiefly prospecting by drilling, although considerable underground work has also been done. A great deal more of the latter will be necessary in order to prepare the ore for mining, in which respect this property is more backward than either the Inspiration or Keystone.

In the Live Oak area the orebody pitches rather sharply to the west and in the western part it lies at a depth of about 800 ft. According to the estimates of the Live Oak engineers, they have developed 15,000,000 tons of ore averaging 2.1 per cent copper.

GENERAL OBSERVATIONS.

So far as known, the Miami district has only one orebody, disregarding its local separation by faulting. This is situated in the flank of the mountain rising from the northern side of "Miami wash," which is a branch of Pinal Creek. This mountain is cut by transverse ravines and valleys, producing a rough and irregular topography. The Arizona Eastern Ry. Co. extended its line from Globe along Pinal Creek, 10 miles to the town of Miami, above which the Miami mine is situated. The power plant of the Miami Copper Co. is at the foot of the mountain, at the terminus of the railway. The concentrates loading bins are near-by. Timber and supplies for the mine and mill are elevated to the mine by an inclined railway. The water supply for the mill is obtained from the Old Dominion mine at Globe, whence it is conveyed by pipe line, by gravity, to Burch. From Burch it is pumped to a tank above the mill, the distance being about four miles and the lift about 575 feet.

There does not seem to be any chance that the Miami-Inspiration-Keystone-Live Oak orebody will extend into any other property, except perhaps at the western end, and its existence adds no values to other properties to the north and south in the district beyond creating the hope that a similar orebody may be found. Prospecting up to the present time has given no support to such a hope. As to the western extension there is a suspicion that another fault has dislocated the orebody, and that beyond the Live Oak it is perhaps to be looked for to the north of what would otherwise be the line.

The Miami-Inspiration-Keystone-Live Oak orebody has now been rather closely delimtied, but all of the companies will probably add somewhat to their reserves. In this respect the chances of the Miami Copper Co. are perhaps the best.

It is not to be doubted that a consolidation of the four adjoining mines would be of economic advantage. By agreement they have adopted the sideline principle, wherefore no litigation is to be expected, but under individual ownership there will be troublesome mining problems along joint boundaries. There would be economy in capital outlay by concentrating the milling in one plant and there would also be economy in operation. Finally, there would probably be economy in smelting the concentrates. At present the Miami product is shipped to distant Cananea. A better

contract was made there than could be made at Globe, only ten miles distant. It would seem, however, that the concentrates of the Miami district ought to be smelted at home.

FUTURE OF CONCENTRATION

By M. P. BOSS.*

Following the introduction of the Frue vanner the public held complacently the thought that that machine would do about all that could be done in concentration. The years that have elapsed since have unveiled additional complexities in proportion as understanding has increased. Sizing and classification have long been in a measure appreciated, but even today are broadening into wider and more universal practice, and are evidently destined to much greater consideration by the general public. It has been and is customary to measure success by profits of treatment, quality of work often being sacrificed for quantity; and often the loss is a final and permanent one. This matter may yet run counter to the conservation tendecy, and thus stimulate a desire to get all that mechanical genius can get—to get out by automatic mechanical means what can now be gotten out by a batea through skillful hand manipulation. At the present stage of the art little progress can be expected by haphazard means. A thorough understanding of the principles involved in the obstacles that yet so thwart engineers is essential to cope with today's problems. This is particularly true in slime treatment. New devices bring hopes, to be followed by disappointments, yet the why and how is continually becoming better understood.

In all concentration two active agents are involved, impellant energy and retardation. Retardation may be liquid and non-directing, or it may be rigid and guiding. In a feed composed of true spheres of absolutely equal size, a concentrate could undoubtedly be completely segregated from a gangue of but little less specific gravity, even if the material was so fine as to be classed as slime, by machines now on the market. In true spheres 'impellant energy' (as of gravity) is in ratio as the cubes of their diameters mutiplied by their specific gravity, while 'liquid retardation' (as in precipitation) is in ratio as the squares of their diameters. This unfailing law is the bogey that is the cause of the greatest troubles in intelligently manipulated concentration. Two spheres of equal size but of unequal specific gravity would meet, in liquid precipitation, equal resistance, their displacement being the same, while the 'impellant energy' would be greater in the heavier sphere. Thus a large grain of gangue will sink faster than a small grain of concentrate. This is a clear reason why thorough sizing is desirable. The closer the sizing, the easier and better the dressing. It is easy to size a coarse material, but the difficulty multiplies with fineness, and in slimes one particle may be several times the diameter of another, an associated particle. From this rises the difficulty with slimes, a difficulty which probably never can be wholly overcome, so that there is little hope of slime treatment through 'liquid retardation' (precipitation or longitudinal hurling).

Rigid and guiding retardation, as on a table, or in a batea, introduces other principles, the horizontal plane estopping precipitation and the finer particles finding their way through the interstices between the larger grains and resting upon the bottom, where they are in a measure protected and are less affected by currents that sweep along the coarser grains. The efficiency of this decreases with depth of material and is a factor of grain diameter. The bed should be thinnest with slime, as a thick bed brings into play the 'liquid retardation' law, that precipitates the larger grains of gangue faster than the fine grains of concentrate. These are principles to consider in regard to riffles and to table-deck treatment, to avoid as much as possible ill effects from liquid retardation. When a concentrate particle has once reached bottom all effort should be made to keep it there. To this end riffles should be so designed as not to have a turbulent raising effect below them, unless material is very closely sized or of widely differing specific gravity.

The foregoing implies that all unencased concentrate material might be segregated from a gangue, even if only slightly heavier, when properly classified. The term classified, rather than sized, is used here advisedly. Material can be thoroughly sized by screens only. Classified is a broader term and includes hydraulic classification, which is a process based on the law of liquid retardation, wherein the heavier particles are smaller than those that are of lighter specific gravity. As we have seen, the latter is more suited to lateral table-deck treatment and the former to liquid retardation. In looking at the acres of concentrating machines in one of the great modern plants of today and realizing that the same machines are greatly overworked for commercial reasons, one quite naturally drops into computing the percentages of the total area that is actually segregating concentrate from gangue, and it is small.

From the present viewpoint, where is the relief? As has been noted, no space is wasted. Yet it is quite probable that in some future day more work will be done on a less area. About as the flying machine was to human travel a half dozen years ago, so centrifugal concentration is viewed today. Yet an impellant energy many times augmenting that of gravity may be developed by high centrifugal action, some like characteristic existing in both, yet with complications abounding for future solutions. When the capacity of present machines has been greatly increased without increase of cost, then a better quality of work may be expected. While very great progress will likely be made in the near years to come, there will likely be ample field for study for many years.

* In Mining and Scientific Press, January, 1912.

BILL AND THE "SUPE"

Now listen to me, while I tells to you,
The tale of the Supe an' Bill McGrue.

Bill he was takin' a little mope
After drillin' his holes in the stuffy stope,

An' settin' down on a timber car
He lights a match to a bum cigar.

He scarcely more than gits a light
When a guy in overalls heaves in sight.

"Takin' a rest?" says he to Bill.
"You bet," says William, an sets right still.

"Aint you got nothin' at all to do?"
"I have," says Bill, "when Im ready to."

"What would you do?" says the stranger guy,
"If the shift boss happened to wander by?"

"I'd sit," says Bill, "like a tired bloke,
An' take my time for my rest an' smoke."

"Do you know," says the stranger, "who I am?"
"I don't, says William, "nor care a damn!"

"Well, I am the Superintendent here!"
Bill's grin extended from ear to ear.
"The Supe" he says, "of the hull big mine?
Thats bully," he says, "that's grand, that's fine;

A mighty good job fer a man to git
If I was you I would tend to it!"

Then Bill leans back on the empty car
An' goes on smokin' his bum cigar.

Benton Braby in New York Times.

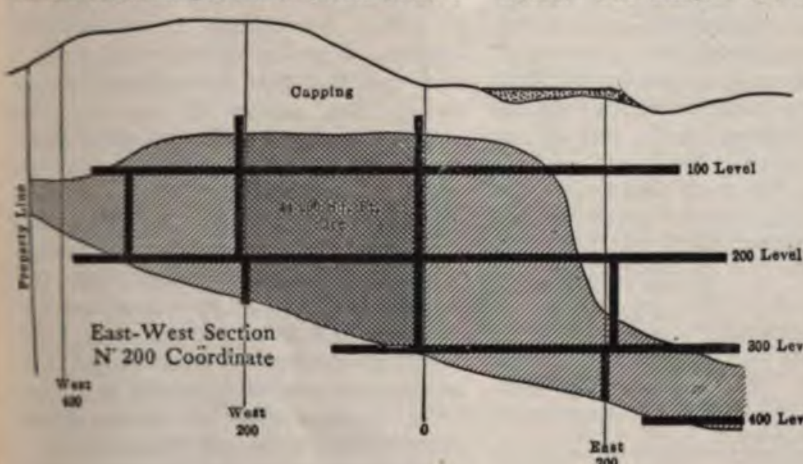
Water softening, where the hardness is due to lime sulphate, may be accomplished by the addition of barium carbonate. Barium sulphate is produced and lime carbonate forms, both of which are nearly insoluble, and will precipitate. Barium hydrate may also be employed, which has the advantage of decomposing the lime salt with the formation of CaO, which will reduce the soluble lime bicarbonate to the insoluble carbonate. The high cost of barium salts is an obstacle to its wide use for this purpose.

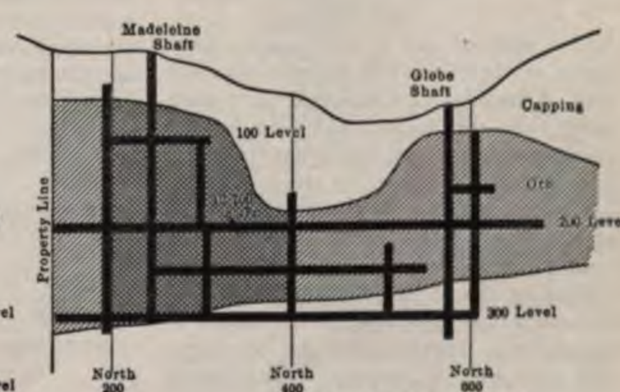
METHOD OF ESTIMATING DISSEMINATED OREBODIES

By FRANK H. PROBERT* and ROY B. EARLING.†

The following practice has been adopted at the Ray Central property, at Ray, Ariz., for estimating tonnage and value of ore developed. Inasmuch as the method can be applied at any property where disseminated ores are developed it is worthy of detailed description.

The property has been laid out and all work done along rectangular co-ordinates, all workings being numbered according to the distance in either direction from the zero point, for example N 400-E 600-E is a drift driven east from a point N 400 E 600. All drifts and crosscuts are run along these co-ordinates with winzes and raises connecting levels at points of intersection. In this way the orebody is first split into 200-ft. blocks to be later subdivided. Cross and longitudinal sections at intervals of 100 ft. and level plans are used in the computation, upon which are plotted all underground workings, churn-drill holes, assays and major geological features. The standard scale used is 50 ft. to the inch. All maps are brought up to date at the end of each month and blueprints showing progress, accompanied by the report of the engineer forwarded to the respective officers of the company.





North-South Section
West O Coördinate
Scale $\frac{1}{1200}$

Low-grade ores require constant and accurate sampling. The copper occurs as finely disseminated particles of chalcocite, chalcopyrite, oxide or native in a silicious schist, or occasionally in the intrusive rocks to which the orebodies owe their origin. To distinguish between commercially mineralized schist and waste is impossible except by careful sampling. All underground openings whether in ore or country rock look monotonously alike, hence the necessity for accurate sampling and assay maps.

Samples are taken in 5-ft. sections starting from a co-ordinate or transit point, care being taken to first clean down the walls. A continuous groove 1½ in. deep and 3 in. wide is cut in each wall. Particular care is taken to secure about the same amount of material from every part of the 5-ft. section to prevent the enrichment of the sample by any small seam of high-grade ore which might occur. About 35 lb. are taken per sample. As the drift advances the groove is continued. The samples are sacked underground, dried, crushed, quartered in split dividers and the final pulp put up in duplicate, one for permanent filing, the other for immediate assay. All determinations are made by electrolytic assay, the apparatus being of the rotating-anode type. The results are recorded on the maps and complete numerical and classified card files are kept in the fireproof vault at the mine office. To avoid the possibility of error, frequent check samples are taken in stretches of from 50 to 100 ft. The laboratory work is also checked by composites and re-assaying of individual samples.

MEASUREMENT OF TONNAGE.

The first step in computing tonnage is to define the workable limits of the orebody on the several maps, taking each set of sections separately. Local economic conditions naturally determine the minimum grade that can be profitably mined, so that in sketching in the areas of commercial ore the limits are defined by the assays. Any marked irregularity is, of course, avoided, the object being to outline the orebody as it will be mined. A run of low-grade assays will often be included in a block while a small tongue of high-grade might have to be discarded from the calculation. If a working has been discontinued in ore, an allowance is made for the probable extension of the orebody a distance of from 5 to 50 ft., depending on the proximity of other workings, the uniformity of the ore and geological conditions. Here the personal equation of the engineer figures in the estimate and intimate knowledge of the district is necessary.

Each set of sections is compared and correlated with the other sections and plans, and altered so that they represent a definite orebody of concrete form. Areas are always reduced rather than added to in making the sections conform. Figs. 1 and 2 are reductions of actual sections used in the computation recently made for the shareholders of Ray Central.

ORE MEASURED IN 200-FOOT BLOCKS.

The cubic content of the orebody is now determined by taking blocks 200 ft. square, of variable depth, designated by the co-ordinates between which they lie, viz., N 200-400, W., 0-200. At Ray Central longitudinal and cross-section maps are available at intervals of 100 ft. so that in calculating any given block, six sections have to be used, three north-south and three east-west as shown in Figs. 3 and 4. These maps show the sectional area of the orebody on each face and through the middle of the block, the areas being measured either by planimeter or by counting the squares on cross-section tracing cloth superimposed on the map, and multiplying by the factor

*Consulting engineer and †Chief engineer, Ray Central Copper Mining Co., Ray, Ariz., in Mining and Engineering Journal, Dec. 16, 1911.

necessary to give square feet. Taking either set of three sections the volume of the block is calculated by the prismoidal formula, which is,

$$V = L\left(\frac{E + 4C + E'}{6}\right)$$

Where V is the volume, E one end area, E' the other end area, C the area of

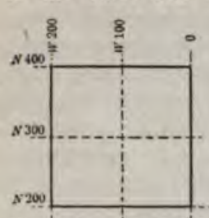


Fig. 3 Plan of 200-ft. Block

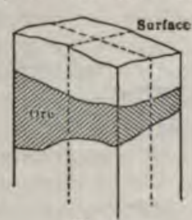


Fig. 4

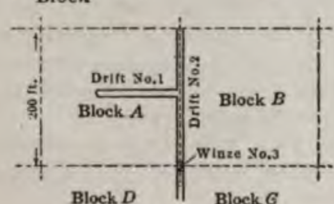


Fig. 5 Plan

center section, and L the length. Inasmuch as there are two entirely separate sets of sections, north-south and east-west, two results are obtained for the volume of each block, which should be approximately the same. If the conditions are such that the two sets of sections should give equally correct results, the average of the two is accepted as the volume of the block. For full blocks 200 ft. square the measurement of volume is simple, but irregular fractional blocks on the edge of the orebody cannot be as accurately estimated. Where, owing to the form of the block, three faces are presented by one set of sections and only one or two by the other set, the result obtained from the first series is accepted.

Throughout the Ray District the ratio of 12½: 1 is used in the conversion of volume to tonnage. The total tonnage is obtained by adding together the tonnages of the individual 200-ft. blocks.

CALCULATION OF AVERAGE GRADE.

The average grade of the orebody thus delimited is determined by the average assay values of the individual blocks. In a block containing both high- and low-grade ore, irregularly distributed, it is obvious that an arithmetical average of all assays in such block would be incorrect. Due weight must be given to each run of assays according to the number of times it figures in the computation.

Referring to Fig. 5, if all assays were given the same weight in computing the value of block A, and subsequently the assays in block B were averaged to give the value of that block, then the assays in drift 2, which is on their common line, would be used twice, while those in drift No. 1 would be used only once. In the same way after all adjacent blocks had been figured the assays in winze No. 3 would have been used four times. In other words the assays in workings along co-ordinates would have twice the representation, and those in the winzes and raises at the intersection of the co-ordinates, four times that of the interior workings, and unless this is guarded against the results cannot be accurate.

It is, therefore, necessary in order that each assay have the same representation in the final result that they be given different factors in individual blocks, as follows:

All assays in interior of a block, a factor of 4.
All assays on side faces of a block, a factor of 2.
All assays at corners of a block, a factor of 1.

In estimating the value of the Ray Central orebody the ratio of ½, 1 and 2 is used, instead of 1, 2 and 4 to facilitate the work, viz., 46 assays in drifts along a co-ordinate line totaling 116.07 are figured as such, whereas 103 samples giving 217.78 from winzes at the corner of a block figure as 51½ samples of 108.89, so that in the block shown, instead of having 488 samples totaling 1027.98, we

DATE Jan. 1, 1911 CLASS Actual
ENGR............ BLOCK N 200-400 W 0-200

	Section		Area in Square Feet	Total
E-W SEC.	N200 300 400	33,500x4	44,200 134,000 14,200	

$$192{,}400 \times \frac{200}{6} = 6{,}412{,}000$$

	Section		Area in Square Feet	Total
N-S SEC.	W 0 100 200	32,000x4	40,700 128,000 20,700	

$$189{,}400 \times \frac{200}{6} = 6{,}313{,}000$$

ACCEPTED (ave.) 6,362,000 cu.ft.
509,000 tons

ASSAYS

Map	No.	Total	Factor	No.	Total
100′ lev....	73	146.72	1	73	146.72
200′ lev....	63	127.24	2	126	254.48
	115	244.09	1	115	244.09
250′ lev....	54	103.17	1	54	103.17
300′ lev....	22	46.67	1	22	46.67
Sections...	103	217.78	½	51½	108.89
...	46	116.07	1	46	116.07
...	12	26.24	2	24	52.48

TOTAL 511½ 1027.57
AVERAGE ASSAY 2.098 per cent.

FIGURE 6

figure 511½ samples giving an assay total of 1027.57 making the average assay for the block 2.098 per cent.

The general assay of the whole orebody is obtained by adding the "tons per cent" of component blocks and dividing by the total tonnage. Summarized the estimation involves:

(1) Computation of tonnage for individual 200-ft. blocks by prismoidal formula.

(2) Computation of average assay for individual blocks with assay factors according to situation.

(3) Computation of total tonnage by addition of block tonnages.

(4) Computation of general average assay, using factors for block averages according to tonnages.

All block tonnages, assays and computations are kept in a loose-leaf book on special forms, Fig. 6, provided for the purpose.

WHAT IS HURTING PORCUPINE

A prominent mining man, in the course of an interview with the Canadian Mining Journal, says that publication, stated that he had twice or thrice offered to pay the price asked for certain prospects in Porcupine, on condition that he first be permitted to spend a considerable amount of money in investigating. In each case this offer was unqualifiedly rejected. The person in question was amply able to carry out any undertaking that appealed to him. He was not only ready and willing but anxious to be responsible for the preliminary development of any reasonably promising claim. But everywhere he found owners asking impossibly high prices and imposing impossibly rapid terms.

This is one general cause of the present decline of public interest in Porcupine. Another incidental cause is the suppression, or non-publication of ..r. Robbins' report on the Hollinger. Still another is the superfluous and glittering generalities that are being published about the Dome, ostensibly from headquarters.

On its own merits Porcupine must stand or fall. Assuredly it needs sane advertising. More assuredly it does suffer from indiscreet booming.

It is high time that the mine owners and operators of Porcupine get together and devise a practical scheme of publicity.

The writing of prospectuses is an art that can be acquired only by long experience. It is rarely that one sees a properly balanced presentation of facts and opinions. The tendency is, of course, so to use the engineer's report as to give a highly favorable view of any enterprise. A result is that many engineers are falling into the habit of making their reports serve the purpose of the prospectus. This is a lamentable tendency, a tendency that should be guarded against most rigidly.—Canadian Mining Journal.

RACIAL COMPOSITION OF MINE WORKERS

By W. J. LAUCKS.*

The importance of immigration labor in the metalliferous mines of the west is shown by the fact that slightly more than two-thirds of the employes are of foreign birth. The racial classification of the alien mine workers is quite different, however, from that of the wage earners in the smelting and refining industry. Among the latter the southern and eastern Europeans are predominant, while the metalliferous miners are of races from Great Britain and northern Europe. The proportion of native Americans engaged in mining is also much larger than that in the smelters and refineries.

RACIAL COMPOSITION OF MINE-WORKERS.

A recent and exhaustive investigation of the government has developed the fact that one third of the metalliferous mine workers of the west are of native birth. About one half of these are descendants of parents born in the United States, and about one-half are native born of parents who migrated to this country from England, Ireland, Germany and Canada. Forty European races are represented among the immigrant mine workers. The north Europeans, or the Danes, Dutch, English, Finns, French, Germans, Irish, Norwegians, Scotch, Swedes and Welsh, constitute two-fifths of the total number of employes. Members of the southern and eastern European races, among which the North Italians, Croatians, Dalmatians Herzegovinians, Montenegrins, and Slovenians are most prominent, form only one-sixth of all those at work in or about the mines. Of the remaining mine workers, the largest racial element consist of Mexicans with a proportion equivalent to about 6% of the total number employed.

GEOGRAPHICAL DISTRIBUTION OF EMPLOYES.

About one-third of the employes in Colorado, Montana and Arizona are native born, but in California the proportion of native born is little more than half as great, the percentage being only 18. Among the foreign born races, the English range in relative importance from 11% of the labor supply at the California mines to 20% at the Montana mines. The Irish show a very much greater variation. In Montana they constitute about one-fifth of the total number of employes, while in California they are a negligible quantity. The North Italians exhibit an even greater variation in relative importance than do the Irish, their proportion in the labor forces ranging from 4% at the mines in Colorado and Montana, and 7% in Arizona, to 36% at those in California. The Mexicans are almost exclusively employed in the Arizona mines, where they comprise about one fourth of all the employes.

The large proportion of Mexicans at these mines, and their practically entire absence in the other districts, is explained largely by the proximity to Arizona of the Mexican border, and the further fact that most of the immigrant Mexicans employed are part of a nomadic labor supply which travels back and forth through the border states and northern Mexico. The Croatians, Finns and Swedes are not represented in the California mines, and the Herzegovinians and Montenegrins have no representation in either the Colorado or Arizona districts. The Croatians and Finns attain their greatest relative importance at the Montana mines, the Swedes are relatively most important in the Colorado district, and the Herzegovinians and Montenegrins have their largest proportions in the California mines. The French and other Canadians show the greatest numbers at the Montana mines, and the Slovenians in the mines in Colorado.

RACIAL DISPLACEMENTS.

The racial changes in the operating forces of the mines during the recent years have been the same in all districts. Native Americans and older immigrants from Great Britain and northern Europe, principally the English and Irish, constituted the original body of mine workers. Some of these came direct from their native countries, while others, owing to the pressure of competition of recent immigrants from southern and eastern Europe, migrated from the bituminous and anthracite coal mining fields of the east, where they had been first employed.

Many of the English came from the mines of Cornwall, and the majority of the members of this race were skilled miners, mechanics, or engineers before they emigrated to the United States. Within recent years large numbers of these earlier employes have left the metalliferous mines. Some have been induced to enter other industries by the offer of higher wages. Others have engaged in small business enterprises in the mining towns or the neighboring cities. Still others have bought farms. The places left vacant by their withdrawal have been, and still are being filled to a considerable extent, by native Americans and by British and northern European immigrants, who have migrated from the eastern or middle western mining areas, or have come from abroad.

Of late years, however, these sources of labor supply have been insufficient, and mine operators have found it necessary to resort to the more recent immigrants from the south and east of Europe. As a rule these southern and eastern Europeans have made their way into the mining communities through employment on railroad construction or maintenance of way work. The number of recent immigrants applying for work is usually greater than the number of places to be filled.

No discrimination in wages has been made in employing recent immigrants. They have been paid the prevailing rate of wages. The presence of such a large force of available workmen, willing to be employed at the prevailing wage scale, has had the effect, however, of retarding any increase in rates of pay which might otherwise have occurred. This tendency to a decline in wages from this cause has also been largely resisted in Montana, and to some extent in Colorado, by the activity of the labor unions. Furthermore, the existence of labor organizations has had a pronounced effect in causing the migration of certain classes of workmen to certain districts. The distinct tendency of native Americans and British immigrants to move into Montana and other northern mining fields, may be accounted for in large measure on the one hand, by the higher wages obtaining in the northern mining fields under a regime of collective bargaining, and, on the other hand, by the labor troubles in Colorado. As a consequence, relatively few southern and eastern Europeans are found in the unionized territory.

OCCUPATIONS MOSTLY GENERAL LABOR.

Practically all of the recent immigrants, as might be expected, are employed as general laborers in and about the mines. Most of them have been farmers or farm laborers in their native countries, and have had no experience in mining. The foremen, engineers and mechanics are either native Americans, the native-born descendents of British or northern European immigrants, or foreign-born Germans, Scotch, English, Norwegians, Swedes, Irish and Canadians, who have had training before

*In Mining and Engineering World, January, 1912.

immigrating to the United States, or have acquired proficiency as mine workers in other mining areas of the United States.

HOURS OF LABOR.

The length of the working day in the different districts ranges from 8 to 12 hours. In Montana, where the employes are unionized, the working day is 8 hours, and the working week 6 days. At the Colorado mines, where the employes are not unionized, the hours of labor vary from 8 to 12 per day, and the working week in a great many of the mines is 7 days. The men employed underground at these mines, however, in accordance with a state law, work only 8 hours per day, and few of those employed above ground work daily more than 9½ hours.

At the Arizona mines the underground employes work 8 hours per day, and most of the mechanics and others employed above the ground work 8 or 9 hours. The longest working day formerly was found at the California mines but by a recent legislative enactment the working day for underground employes has been limited to 8 hours.

DAILY EARNINGS.

About four-fifths of all the adult mine workers earn $3.50 or more each day. A considerable proportion, or about one-eighth, have daily earnings of $4, or more than that amount. Those who earned less than $3.50 are found chiefly in the groups of employes earning $1.75, but less than $3.50, which aggregate about one-fifth of the total number. Less than 1% earn less than $1.75 per day.

The level of wages in Montana is higher than that in any of the other districts. Of all the Montana employes, 96% earn $3.50 or more daily, and 14% $4 or more. No daily wage of less than $2 is paid to any employe. The greatest range of earnings is shown in the Arizona district, where Mexicans and North Italians receive a daily wage of $1.25 to $1.50. The earnings of the Americans are much higher. The greater number receive $3.50 or more daily, a considerable proportion $4 or over.

The general level of earnings at the Colorado mines is somewhat lower than that of the earnings at the Montana and Arizona mines, although the range of earnings at the Colorado mines was not so great as that at the Arizona mines. The principal wage group for the Colorado mine workers is that of employes earning $3, but under $3.50 per day, which includes about one half of the total number. Of the remainder, about one-fourth receive a daily wage ranging between $2.50 and $3. The lowest general level of earnings is that of the California metalliferous mine workers. About four-fifths of the California wage earners get less than $3 per day, as compared with corresponding percentages of 28, 0.1 of 1, and 35, respectively, for Colorado, Montana and Arizona. The principal wage group for the employes of the California mines is that of those earning $2.50, but under $3 per day. This group includes 75% of the total operating forces. The comparatively high wages in the northern or Montana districts, is due to the predominance of Americans, English and northern Europeans, and to trade union activity. In Arizona and California, the unfavorable showing as to wages arises from the weakness of labor organizations and the prominence of Mexicans and southern and eastern Europeans in the operating forces.

CHARACTERISTICS OF IMMIGRANT LABOR.

More than one-third of the total number of foreign-born mine workers have been in the United States less than five years, and one-fifth have been in this country five, but less than nine years, or in other words more than one-half have resided in the United States less than ten years. More than 'one half of the immigrant employes are married, but 27% of the total, and a considerable higher percentage of the southern and eastern European married employes, have left their wives and children abroad. More than two-fifths of all the miners of non Engilsh-speaking races have not acquired any speaking knowledge of the language. One fifth of the foreign-born employes can not read in any language, and a considerably greater proportion are unable to read English. About one-half have become fully naturalized, and one-fifth have signified their intention of becoming citizens. In all respects the southern and eastern Europeans, as compared with the British and northern Europeans, exhibit comparatively little tendency toward permanent settlement and assimilation.

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EDISON'S NEW SCHEME

Thos. A. Edison's idea is to concentrate ores with as little human power or purchased material as is possible. He is now working upon the same lines of a power to separate mineral from gangue that he worked upon in the production of electric light; that is, to make natural forces do the work instead of grinding rock between steel faces as is today practiced in the use of Cornish rolls. His idea is further to concentrate dry, so as to make commercial orebodies that are located far away from water, and while he says that the use of a little water in this system is beneficial, yet he can save by the dry process within 5% of the saving that he can make by the partially wet system. Edison proposes to do away with costly concentrating tables, and to entirely abolish the use of stamps, and when his own rolls are too large for the product to be treated, the use of a smaller Edison crusher is to be used. Another promised step in advance of present concentration systems will be the lightness of the equipment, and the small cost of installation, admitting of the establishment of a plant any place, provided power can be obtained, and a daily treatment of from ten tons of ore upwards.

While electricity plays an important part in the new system, there is nothing yet made public as to the general process. With the exception of Hon. W. A. Clark and Henry B. Clifford—the latter responsible for turning Edison's attention to sulphide ore concentration—no mining men have so far been allowed to visit the laboratory. From Mr. Clifford it is learned that the operation is simple and anything but startling. It is the adaptation of Edison's ideas of crushing and concentration and final division of the various metals by the application of a new force—until now—never successfully used in ore treatment. Mr. Edison is making no extraordinary claims. He simply says that he feels he will make a little higher saving, at a little less cost than any system today in use, and that if power can be obtained the process will work with or without water.

Experiments are being made upon Clear Creek and Gilpin county, Colorado, ores, also Anaconda and Clark's Butte City ores, Coeur de Alene lead and zinc sent by the American Smelting & Refining Co., as well as tungsten from Boulder County, Colorado, and the Bassick mine of that State.

As an evidence of faith the inventor and Mr. Clifford have in the new process, the latter says: "We will pay the freight upon ton lots of sulphide ores high in silica, carrying lead, zinc, iron or sulphides of copper, and make reports to the owners free of all charge. Shipments may be made in sacks, tagged with the name of the mine. Write and give description and we will advise you whether to ship or not. Send small sample with letter to Henry B. Clifford & Co., 17 Babcock Place, West Orange, N. J."

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The efficiency of a water wheel is the ratio of its output in power to the total power of the water and head used.

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The amount of pull on a tape will have a very appreciable effect upon its length; ordinary light 100 foot tapes will stretch 0.01 to 0.02 ft. with an increase of 10 pounds in the pull over the ordinary pull.

ELECTROSTATIC WORK AT CANANEA, MEXICO

By F. S. MacGREGOR*

The property of the Calumet & Sonora Mining Company is about two miles from Cananea, Mexico, and includes a large deposit of galena, chalcopyrite, pyrite and zinc blende. The wet concentrator makes high-grade lead concentrate, copper-zinc middlings and tailings. As there had been no way to utilize the middlings, they were piled pending the discovery of a successful method of treatment. At the same time the ore mined was selected so as to make a mill feed containing as much lead as possible with the minimum of zinc.

ELECTROSTATIC PLANT RECENTLY COMPLETED.

After investigating various methods, electrostatic separation was found to be the most suitable, and J. N. Houser, the superintendent, proceeded with the erection of such a plant. This was put into operation during the first week of August, 1911, and the work since then has fully equaled the results obtained in the preliminary tests several months previous.

The plant is in a frame building, shown in the accompanying illustration. Above the bins for finished products are two floors for separators, and in a tower are two screens for sizing. The middlings are trammed in mine cars from wet concentrator to the mill, and a platform elevator lifts the cars to the level of the feed bin (shown at the left of the mill). Before dumping, the car is weighed and sampled.

Part of the mill feed is taken from the stock pile, the rest comes from the concentrator. As the major part of this stock pile has stood for some time, there has been a solvent action of the copper from the chalcopyrite and other copper minerals and a precipitation of the copper from the solution thus formed on the zinc-blende particles, rendering them good conductors.

As the separation of the zinc from the other sulphides depends on the difference in conductivity, it was necessary to alter this condition. To do this the stock-pile ore is dumped into the tanks beyond the first feed bin and given a bath of weak potassium-cyanide solution. The cyanide is pumped from a tank below, and after using is drained through the filter bottom and used for the next tank. This solution dissolves the minute film which is formed on the zinc, and the difference in conductivity is restored.

*Metallurgist with Huff Electrostatic Separator Company, 60 India street, Boston, Mass., in Engineering & Mining Journal.

CONDUCTIVITY DIFFERENCES INTENSIFIED BY COPPER-SULPHATE SOLUTION.

In this case natural causes have accomplished what may be done artificially —by giving a zinc product containing barite, rhodonite or other heavy gangue a bath of copper-sulphate solution. After drying, the zinc may be repelled from the heavy gangue, which could not be removed by tabling in the first place.

Under these tanks and bins runs a conveyer belt, and over it a traveling automatic feeder. By this arrangement the mill can be fed either from the stock pile or with fresh middlings. The belt delivers to the drier, which is of the cylindrical type.

From the drier the ore passes to No. 1 elevator, which delivers to an oversize (2 mm.) trommel on the first floor. The oversize passes to a small set of rolls, and the undersize to No. 2 elevator, which delivers to the screens in the tower. Three sizes are there made, 2 mm. to 20 mesh, 20 to 40 mesh and through 40 mesh.

The material above 20 mesh is separated on the Huff roll-type separator.

Huff Electrostatic Separator at Calumet and Sonora Mill.

Calumet and Sonora Forty-Ton Electrostatic Plant.

The fine material passes to separators of the Huff toboggan type, which has been used only recently. The American Zinc Ore Separating Company, in its plant at Platteville, Wis., has developed, for the treatment of the fine material, a type which has no revolving parts, except a slow-speed feed roll at the top. As shown in the illustration, it consists of a series of curved surfaces over which the ore slides by gravity. This type is adapted for fine sizes only, the roll type being adapted to the coarser material.

FORMER WASTE NOW PROFITABLE.

The finished products are termed the "copper" and "zinc" and fall directly to the bins; these are shown at the lower right-hand corner of the mill. From these bins the products may be drawn off into wagons and hauled to the railroad.

A 20-h.p. electric motor drives the plant, power being obtained from the power plant of the Greene-Cananea Copper Company. The separating plant has shipped regularly since starting and has given no trouble. About 40 tons per day are handled, approximately 20 tons being the daily output of the wet mill and the rest from the stock pile. In practice the mill is run on one class of material until the other has accumulated suffi-

ciently to make a several days' run. The stock pile assays: Silver, 3 oz.; zinc, 30; copper, 7; iron, 15, and lead, 3.5 per cent. The present wet-mill middlings assay: Zinc, 40; copper, 5; iron, 10.5, and lead, 1.5 per cent. The zinc product averages 55 per cent zinc, 5 per cent iron; and the copper product 9 per cent zinc, 16 per cent copper and 10 oz. of silver. Only three men per shift are required—an American shift boss and two Mexicans.

As can be seen both of these products are of value and can be economically smelted. Heretofore this material has been lost, as there was no market for the two mixed. Not only has this saving been effected, but the problem of mining has been simplified, enabling any stope to be mined whether it furnish lead or zinc, where previously zinc had been avoided.

MONTANA TOPOGRAPHIC MAP

The United States Geological Survey is constructing a great topographic map of Montana and has already surveyed nearly two-fifths of the State at a cost of a good many thousand dollars. When completed the map will be not only the largest but the most detailed and exact map of Montana in existence. The surveys thus far made include many areas considered to be of the highest economic importance, particularly the mineral-bearing regions, although considerable portions of the more important areas for irrigation, agriculture, and forestry have been covered. The topographic map is a base for engineering work of all classes, as well as a guide map for ranchers, tourists, miners—in fact, for everyone desiring a knowledge of the out-of-doors through exploration. From the standpoint of the Geological Survey, a topographic survey is most important as furnishing a necessary base for all detailed geologic investigation, a considerable amount of which has been prosecuted in Montana.

THIS YEAR'S SURVEYING ACTIVITIES

During the present season the United States Geological Survey topographic engineers have been and are now at work on the survey of the areas known as the Midvale and Nyack quadrangles, lying just south of the new Glacier National Park, a fine map of which was completed last year. The work in the Midvale quadrangle will be finished this year, but it is doubtful if the topographers will complete the survey of the Nyack quadrangle before wintry weather makes surveying impossible in the high altitudes. The surveys of the Brockton and Sand Butte quadrangles, in the extreme eastern part of the State, will be completed; these quadrangles lie partly within the Fort Peck Indian Reservation. Other work includes profile surveys of Clark Fork from St. Regis to Lake Pend Oreille and township surveys of some 200 square miles or more in the southwestern part of the state—south and southwest of Butte, in the vicinity of Melrose. This area is being mapped with a view to future detailed geologic investigations of the phosphate deposits recently discovered by the Geological Survey.

In the survey of these areas in Montana seevn topographic engineers and twelve assistants, accompanied by experienced mountaineers performing the duties of cooks and teamsters, have been at work this year.

The maps covering the present field season's work will be published and available for distribution in about a year, and notice will be given of their completion. In the meantime, as soon as the office drafting is completed, a small edition of photolithographic copies of the maps will be printed for the use of engineers, surveyors, and others having urgent need for the information contained therein before the regular maps can be published.

The government's survey of Montana is being undertaken piece by piece and in widely separated areas, as has already ben indicated, each map as issued representing a rectangular area called a quadrangle. The maps are on three regular scales—approximately 1 mile to the inch, 2 miles to the inch, and 4 miles to the inch. The Nyack and Midvale maps will be on the scale of 2 miles to the inch and the Brockton and Sand Butte on the scale of 1 mile to the inch. Besides the regular maps several on special scales have been issued, such as the Butte, the Helena, and the Marysville special maps.

VALUE OF TOPOGRAPHIC MAP.

The value of a topographic survey of any area is generally understood and probably almost everybody in Montana appreciates the adantages of having the government's topographic maps. They show all physical characteristics of the areas mapped that would be legible on the scale used—hills, slopes, valleys, streams, etc., and the altitude of many points. In addition to exactly portraying natural features, they show all the works of man—railroads and bridges, wagon roads and trails, towns, even individual houses. The rancher who buys one of these maps can therefore locate his home and note the elevation above sea level of the ranch house and of any portion of his ranch and the range.

In fact, the map is a guide which shows the relative position of all features of the country to the farmer, the miner, the prospector, the hunter, or the automobilist, as well as to the experienced surveyor or engineer. Thousands of these topographic maps of areas in Montana have been sold and distributed by members of Congress, and the demand is constantly increasing. They are recognized as indispensable to engineering and land development.

SOLD AT NOMINAL COST.

Topographic sheets are sold by the Director of the Geological Survey at Washington, at the nominal rate of 5 cents a copy or $3 a hundred if at least 100 copies of any map or maps are purchased, a price estimated to cover only the cost of paper and printing. The survey will also furnish without charge an index map showing the quadrangles which have been mapped in Montana.

The making of this map of Montana is but a part of the construction of the topographic map of the whole United States which the Geological Survey is completing as rapidly as Federal appropriations allow. At the present time about 37 per cent of the area of the United States has been thus surveyed and the maps engraved and printed.

The ultimate strength of rivets in structural steel work, assuming that the distribution of the load was uniform on all rivets and that the friction of the plates is negligible, has been determined to be from 49,000 to 80,000 pounds to the square inch for steel.

Chills are metal molds used for certain castings, such as car wheels, where a hard surface is wanted, this being accomplished by the sudden cooling of the hot metal as it comes in contact with the comparatively cold surface of the mold.

When zinc dust is shaken in water in the presence of air, hydrogen and hydrogen peroxide are produced, but in the absence of all traces of oxygen the hydrogen peroxide is not formed Hydrogen is formed whether oxygen is present or not.

Sand used for cement work should be composed of hard siliceous material, free from vegetable loam, clay, sticks and organic matter. It should preferably be of coarse grain or of graded size with the coarse grains predominating.

Zinc blende is occasionally rich in gold. It is frequently high grade in silver and has at times been mistaken for tellurium, as was the case for several years at the Carson Creek mine, in California.

ELECTROLYTIC ASSAY OF CYANIDE SOLUTION

By C. CRICHTON*

Some years ago Mr. Erskine, chief metallurgist to the Kleinfontein group, had his attention drawn to an article in an Australian journal, giving a description of an apparatus for the assay of gold-bearing solutions by electrolysis, and as this method as opposed to the usual precipitation or evaporation processes seemed to indicate a great saving in labor and time expended he decided to give it a trial.

The results obtained from the first experimental run were in every way satisfactory, and during the four years in which, at the Kleinfontein group central administration assay office, this process has been in constant use no inaccuracies in the results obtained have been detected. From time to time check assays of the solutions have been made by means of evaporation with litharge, the values shown by the two methods being identical.

The estimation of metals by means of electrolytic deposition is in general use in most laboratories, the only difference between the determination of gold and, say, nickel or copper, by this means being that in the latter case the increase in weight on a platinum cathode is noted, and in the former a lead cathode is used and the gold obtained by cupellation. The apparatus at present in use at the above assay office consists of four oblong frames 2 ft. 10 in. by 3 in. by 6 in., connected in parallel and each holding eight beakers. The frames or boxes are provided with two copper rods.

ANODE CONNECTION ROD.

The anodes consist of ordinary 5-16 in. arc lamp carbons, and are held in position in the center of each beaker by means of clamps fitted to a horizontal copper bar which runs parallel to and 6 in. above the top of the box. By means of a slot and thumb screw the anode connection rod is attached to two uprights fixed at either end of the box, so that each section of eight carbons may be either lifted clear of the beakers or lowered, as required, in one movement.

CATHODE CONNECTION ROD.

This runs along the front side of the frame, slightly above the top and about 2 in. from it; at suitable intervals along the rod are soldered eight single flexible insulated wires, forming a connection for the lead cathodes.

DESCRIPTION OF THE CATHODES.

The cathodes are made from ordinary assay lead foil, a suitable length being 9 in., and as the foil is usually obtained in strips 36 in. long a good quantity of the necessary lengths can be obtained in a short time by cutting the strips of foil into four equal portions. About a dozen of the lengths are placed together and inverted V-shaped pieces cut out from along the edge intended for the bottom of the cathode; this is to allow for the better circulation of the ions through the solution. Arrangement has to be made for connecting up with the flexible wire from the cathode rod; for this purpose a strip about ¼ in. broad is all but severed from one end of the foil and is folded over, forming a terminal. The two ends of the lead are now brought together and connected by folding the edges; to ensure a smooth surface and circular shape a glass bottle having a slightly smaller diameter than the inside of the beakers in use will be found to be convenient for this operation. Very little time is occupied in making the cathodes. A native can, during a very few hours, make a sufficient number for 200 or 300 assays.

The necessary current for the deposition of the gold in solution on to the cathode is obtained from three 2-volt accumulator cells, which, being connected in series, give a terminal pressure of just over six volts. The current varies, of course, with the resistance offered by the solution through which it passes, i. e., the stronger the solution is in KCN the greater will be the amperage. For example, a solution having a strength of 3 per cent KCN passes 0.1 of an ampere, and a slime solution (0.02 per cent KCN) will take a current of about 0.04 ampere. The accumulators are charged from a direct current lighting circuit through a suitable lamp resistance, and connection can be effected between the lighting circuit and accumulators, or accumulators and electrolytic apparatus, as desired, by means of two-way switches.

Little remains to be said except that perhaps a few details regarding the modus operandi may be of interest. The usual number of solutions assayed each day is 22, which are sent up in marked bottles and placed in the beakers belonging to the apparatus, which are prepared the previous evening, so that as soon as connection is made no further attention is required. The time required for the complete deposition of the gold is four hours, after which period the carbons are removed clear of the beakers, the current is switched off and the lead cathodes disconnected and removed to a hot plate to dry. When dry these are folded into a small compass and cupelled with a little silver, parted and weighed, the values being reported to the cyanide works manager by 11 a. m. Although from start to finish this process occupies five hours, only a few minutes are expended in actual personal attention, and the measuring out of the quantities of solutions can be done either by the cyanide works shiftsman, or as in our case by the reduction works sampler. I might mention that if 20 A. T. of solution are required for use instead of 10 A. T., the same time only is necessary for the complete deposition of the gold on to the cathodes.

Precautions should be taken against having the carbon anodes in contact with gold-bearing solution in the absence of any current passing through. Negligence in this particular results in gold being precipitated on the anode.

In the event of a solution affording too great a resistance to the current, the addition of a small quantity of KCN will remedy this and accelerate the deposition of gold.

It has also been found advantageous to add a little ammonia to solutions which deposit salts.

I regret that I cannot give the name of the author to whose article I have already referred, neither have I the name of the journal in which it appeared.

*Presented to the Chemical Metallurgical and Mining Society of South Africa, Sept. 16, 1911.

MINE EXAMINATION EXPERIENCE

Several months ago the writer was commissioned to make an examination of a group of mines in Mexico, writes a mining engineer to the Mining and Engineering World. The republic of Mexico is a rather large country, so this story might fit in almost anywhere down that way. Before leaving for Mexico I was supplied with copies of two separate type-written reports on the property I was about to examine. These reports had been made by two different men, each of whom signed himself "Mining Engineer." In addition to these type-written reports there was a description of the property printed in the form of a neat folder, which had been prepared and intended, if not used, for the purpose of selling stock in the company.

The mines were in charge of an American, a fellow townsman of the men who were putting their money into this venture. I made particular inquiry about this superintendent, as I was desirous of knowing whether there was any incentive for him to deceive his friends. I learned that he received only a small salary—$150 per month; that he was a co-owner with the others, and his only chance for

making money out of the enterprise was to so manage it as to make it a successful concern. The two type-written reports on the property indicated that these people were in unusually good luck in securing so good a group of mines, yet, notwithstanding the promising outlook, there was still much development work to be done, machinery to purchase and install, and much more money and time would still have to be spent there before any hope could be entertained of making the operation profitable.

So evident was the need of more money that this association of friends and neighbors began to think it might be necessary to call upon some others to come in and share in their good fortune, and incidentally, in the meantime, to supply some of the sinews of war now so necessary to success. In order to properly present the proposition to their personal friends and to the public, it was deemed essential to have an examination made which would corroborate the reports already in hand and bring everything up to date.

I was the one selected to make this final examination, and this story is merely a brief outline of my experience on that trip, including a hint of the character of the kind of report I was obliged to submit to the hopeful owners upon my return. I must say these fellows were about as clean and decent a lot as it has ever been my fortune to meet among those engaged in the mining game. They were absolutely straight, and if they had a good thing they wanted to be sure of it, and, if not, they did not propose to take advantage of their friends and blow them in to get even themselves.

I studied the several reports carefully in order that I might be familiar with the property upon my arrival on the ground. The descriptions in the reports were intelligent, and I could detect no discrepancies that seemed to be of importance or which suggested that all was not right, so I soon gained a very fair idea of what the property was like before I had crossed the border line into the "Land of Manana." * * *

I found the superintendent of the mines without difficulty. He was standing in the doorway of an adobe house, the best one I had seen on the trip thus far. He certainly was agreeable enough, and seemed very glad to see me, and we were soon partaking of a good meal supplied by a variety of canned goods from the stock in the little store he was conducting here. I soon learned a number of things. First and foremost, Mr. Superintendent was doing a lucrative business here with the inhabitants for twenty miles each way up and down the river, on the company's capital, selling them all their provisions, clothing, and various other things, at a profit of 100 per cent and up; second, he had been up the hill to the mines but twice since his arrival in camp several months previous, but this, as I afterwards learned, did not make so much difference; third, he seemed very well satisfied with the way things were going. His salary and the profits from the store made him a very comfortable income, and he was prosperous, whether the mines were or not. That afternoon he took me up the mountain and showed me around, and after explaining as well as he could, told m to "go to it."

To say that I was astonished at what I saw would not be telling the truth. I found here just about what I had anticipated—only worse. The type-written reports described one of the mines of the group as having a vein twelve to twenty feet wide, which outcropped from the bottom of the canyon up the side of the mountain, the summit of which was 800 ft. above the river. On this claim I found no vein at all, but on the summit of the hill there lay a flat sheet of quartzite, 30 ft. in thickness, and which was a remnant of a formation which had once covered many miles of this region. I observed similar remnants of the same formation on several of the neighboring hills. This quartzite contained no value whatever.

On another claim the reports conveyed the information that the ore had been "so rich that thieves—the 'gambocinos'—had stolen it." I found a small vein in extremely hard rock. The vein was pinched at both ends and at the bottom, and the best ore I could find would not assay $2 per ton.

On a third claim, according to the reports, there was a quartz vein six to twelve feet in width, carrying abundance of free and visible gold. This vein in the widest place I could find was about two feet across. Two tunnels 100 feet apart, had each been run in on the vein about 100 feet. In these tunnels the average width of the vein did not exceed two inches, and the greater part of the vein was a mere seam. At one place in one of the tunnels there was about four inches of ore, four feet in length, that here and there showed a little free gold. The average value of the ore in this vein was less than $3 per ton over a width of two inches.

At a fourth place a shoot of high-grade copper ore was described in the reports. The ore was high-grade malachite, but an ordinary ore sack or a wheelbarrow would hold the entire amount. It was only a little pocket in the greenstone.

At the fifth place, and the last, there really was a good-sized vein. It was from four to twelve feet wide, well defined, and outcropped at intervals for a mile or two across the country. At one place on this property a shaft had been sunk about 120 feet, and a drift run south twenty feet or more, at a depth of eighty-five feet from the surface. This work had been done in broken ground, which was of medium hardness and of no value. About 125 feet from this old shaft an ore-shoot outcropped boldly, the rock being extremely hard. The shoot had a trend to the northward, towards the shaft. In this hard vein several Mexican miners were laboriously sinking a hole, having reached a depth of twelve feet. Progress was very slow and they still had fifteen feet to go to get as low as the collar of the shaft nearby. Samples taken from this shoot of ore did not indicate that the property would soon be startling the world by its phenomenal output, though it would perhaps startle the stockholders when they were called upon to make good the deficit on the operating cost.

The mining work was in charge of an American miner. I asked him what he thought of going down in the shaft and driving through the comparatively easy ground to the ore shoot, which would be reached in a short distance, and at a depth of 115 feet, which it would take some time to reach in the new shaft and cost a great deal of money. He replied he had not thought of it, and made some sort of complimentary remark about my practical ideas. I started to walk away when he called after me. I stopped and he came up to me and asked with earnestness if I knew where he could get another good job. I learned that over $10,000 had been spent in the development of this vein on an adjoining property and no profitable ore had been found. The ore looked well and the vein was of good size. It possessed, in fact, every desirable feature except value.

When I returned to my home and submitted my report, the owners were astonished at the revelations therein made, and particularly at the duplicity of their fellow townsman and friend, their superintendent. They paid the remainder of my fee promptly, and even went so far as to say it was the most sensible money they had as yet put into the enterprise. This is not an unusual instance. It is altogether too common.

Good, and honest men, men of business experience and generally acknowledged to have sound judgment, invest thousands of dollars on the advice of some acquaintance, whose knowledge of mining amounts to nothing. His report may seem plausible and honest, but unless he has the experience he cannot safely pass upon the property as a business proposition, and when this lack of knowledge is coupled with a tendency to be dishonest the investors are "up against it."

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CONTENTS:

The domestic gold output is derived not only from ore but also from gravels of placer mines. A considerable portion of the gold output is also from copper, lead and mixed base-metal ores. Exact figures for quantities of gravel washed are not available, but it is estimated that the volume was about 80,000,000 cu. yds., with an average value per yard of 12 cents for the United States proper and about 4,418,000 cu. yds., with an average value of $3.66 per yard for Alaska in 1909; and about 100,000,000 cu. yds., averaging about 11.5 cents per yard in the United States proper, and [illegible] cu. yds., averaging about $3.20 per yard in Alaska in 1910.—Mining Science.

STARTLING DECEPTIONS OF UTAH COPPER

The fifteenth quarterly report of the Utah Copper Company, covering the last quarter of the year 1911, although exceptionally quiet and modest in tone nevertheless, upon casual scrutiny, discloses startling deception and inconsistencies, regarding the alleged cost per pound of production of copper. And—by implication—the report shows very great economic advantage of underground mining as compared to extraction of the ore by steam shovels.

Of the total tonnage of ore mined and treated for the quarter, the report states that "about 73% was mined by steam shovels and about 27% came from underground mining operations," that "the average assay of the ore treated during the quarter was 1.418% copper," (28.36 pounds), and that "the average cost per pound of net copper produced during the quarter * * * was 7.85 cents, as compared with 7.56 cents for the third quarter of 1911." The proportion of tonnage of ore mined for the third quarter is given in the report for that quarter as "76% by steam shovels and 24% derived from underground," and the grade of the ore is stated as being "1.4829%"—29.60 pounds of copper. The higher costs per pound of copper produced for the fourth quarter is attributed to "the decrease in average assay value of the ore and the increased cost of operations during the winter months."

In order to arrive at a fair conclusion as to the comparative cost of the production of copper by the respective methods—as shown by the several reports of the president and manager of the Utah company—it will be necessary to quote briefly from previous annual reports. Manager D. C. Jackling in his report for the year 1907, and to January 24, 1908, page 14 says:

JACKLING'S UTOPIAN METHODS.

"The primary development of the property was laid out with a view to underground mining by caving methods and, until the starting of the Garfield plant, practically all the ore extracted was mined in this way. The operations of steam shovels have, however, proved so satisfactory and economical that underground mining is being abandoned as rapidly as possible. At the present time about 25% of the total tonnage extracted is coming from underground work, and practically all of it from the north side of the canyon.

"There are some advantages in continuing underground mining in some portions of the property, because the ore mined in this way is taken from the ore bodies lying directly beneath the capping, RESULTING IN THE CAPPING CAVING INTO THE OPEN STOPES AND BREAKING ITSELF, SO THAT IT IS NOT NECESSARY TO BLAST IT FOR STEAM SHOVELING. (The caps are ours.) On the north side of the canyon we have a high point of ore, containing about 1,500,000 tons which will be mined entirely by underground methods, as it will be more economical to mine it in this way than to strip it and mine by steam shovels, on account of the expensive preparation necessary to operate the shovels and remove the capat this high elevation. When the ore is removed at this point, the overlying capping will drop to a level conformable with the surface in the surrounding vicinity, AND WILL EVENTUALLY BE REMOVED BY STEAM SHOVELS, as the adjoining areas are stripped. WITH THE EXCEPTION OF THIS NECESSARY PIECE OF UNDERGROUND WORK WE EXPECT THAT NO FURTHER MINING OF THIS CHARACTER WILL BE DONE, AND THE ENTIRE PROPERTY, ON BOTH SIDES OF THE CANYON, WILL BE WORKED BY STEAM SHOVELS."

It may be here observed that underground mining of the section above referred to was completed and the "caving in" and "breaking of the capping itself" —including a large area of NEIGHBORS' GROUND—was fully accomplished some three years ago. And, although the capping actually BROKE ITSELF UP into excellent condition for steam shoveling, no attempt has since been made to shovel up and remove it, the shovels being meanwhile required in more pro-

ductive service on other parts of the property.

In the annual report for the year 1909, page 10, Manager Jackling says: "DURING THE YEAR THERE WAS A GRADUAL DECREASE IN THE QUANTITY OF ORE MINED BY UNDERGROUND METHODS, AND BY THE END OF THE YEAR THIS METHOD OF MINING WAS PRACTICALLY DISCONTINUED. During the first quarter of the year the ratio of underground ore to the total ore mined, was in excess of 21%. During the last quarter less than 3% of the total ore mined came from underground. The averages for the entire year were 13% of underground ore and 87% of steam shovel ore. A considerable portion of the underground mined ore CAME FROM THE DEVELOPMENT WORK."

PRODUCTION AND COSTS.

Although no information was given in the report for this year—1909—as to the copper contents of the ore, nor the number of tons treated, it was unofficially stated that the average for the year was 1.89% or over six pounds of copper per ton in excess of that contained in the ore treated for the year 1910 and over eight pounds in excess of that contained in the ore treated for the year 1911. The cost of copper produced for 1909 is stated to be "8.787 cents per pound," and compares with 8.069 cents for the year 1910, and an average of 7.70 cents a pound for the two last quarters of 1911. Of the ore mined for the last quarter of 1911—as previously stated—27% was derived from underground mining—and compares with 24% for the previous quarter (no figures are given for the first half of 1911) and 18% for the year 1910, and 13% for 1909 and, although the copper tenor of the ore has shown gradual and persistent depreciation, it will be observed that the HIGHEST COPPER CONTENT of ore treated and HIGHEST COST OF PRODUCTION prevailed during the year 1909, during which period much the largest proportion of ore treated (82%) was obtained by operation of the steam shovels. And that the LOWEST GRADE OF ORE TREATED, AND LOWEST COST OF PRODUCTION prevailed during the latter half of 1911, when the ore obtained by underground mining reached its highest proportions. In fact, the cost of production of copper, as clearly shown by these reports, ROSE AND FELL IN ALMOST EXACT RATIO as the proportion of ore mined by the respective methods varied in their RELATION TO EACH OTHER. And this, in addition to the fact that the cost of the ore mined by steam shovels is further supplemented by the cost of stripping which for each ton of ore mined by that method adds an additional burden—which must be met at some time by the shareholders—of MORE THAN ONE AND ONE-HALF TIMES the entire cost of each ton of ore MINED BY UNDERGROUND METHODS by the Ohio Copper Company upon similar ground, and under precisely similar conditions to those which obtain in respect to ores mined by the Utah company.

This relative disparity in the cost of production of copper, by the respective methods would seem to give hope of the early abandonment of the steam shovel fiasco, as was finally done in case of the many silly and absurd attempts that were made to extract the copper from the ores without possession of elemental knowledge of the business, and by the use of devices and practices in direct violation of all modern methods. And this hope might be further encouraged by the fact that during the month of January of this year, the proportion of ore obtained from underground was in excess of 36% of the entire volume of ore mined and treated for that month.

The actual tonnage of ore treated for the month of January, 1912, was a little more than 490,000 tons, of which about 170,000 tons was obtained from underground mining. Approximately 140,000 tons of this ore was obtained from the Barnsdall-Pay Roll claims, and the balance from irregular fragments of ore-bearing ground which still remains on the east side of the canyon in the original Utah grounds. But, although there is urgent need for application of some change in methods in this as well as all other departments of the company's affairs, no change can be expected until the present struggle of the insiders to distribute sufficient of the treasury shares to recoup their enormous advances to the stripping deficiency funds shall have been rewarded with some measure of relief which, for the immediate future, seems hopeless.

THAT INVESTORS MAY KNOW.

In order that bona fide investors in the shares of this company may form rational conclusions regarding the practical effect of the company's mining methods upon their individual holdings, some brief observations respecting the cost of stripping and its possible liquidation should be of interest. The number of cubic yards of capping removed during the first quarter of 1911 is not given in the report for that quarter, but that of the last three-quarters is stated in the respective reports as follows: Second quarter, 1,395,504 cubic yards; third quarter, 1,595,095; fourth quarter, 1,520,058 cubic yards, being an average of a little more than 1,500,000 cubic yards for each quarter, and a total of over 6,000,000 cubic yards for the year. From the total sum of costs for that work done for the year 1910, as deduced from the auditor's report, we find that the cost was a little more than 41 cents per cubic yard. Applying that rate to 6,000,000 cubic yards removed in 1911, we find the total cost was $2,460,000, the same being equal to 2.64 cents a pound for the entire copper product of the year which, if added to the assumed cost per pound of copper produced—7.85 cents—as stated in the last quarterly report, would show an actual cost of production per pound of copper for the year of 10.29 cents. One would not have to pursue the analysis much farther to disclose the fact that THE SUM DISBURSED IN DIVIDENDS for the year 1911 EXCEEDS THE ACTUAL NET EARNINGS for the period by many hundreds of thousands of dollars.

Of course we are aware that it is claimed by the management that payment of these costs are being properly deferred, and that they are to be distributed over a series of years, upon the pretense that large areas of ore-bearing ground is being stripped IN EXCESS of the daily requirement of their mills. But we have repeatedly shown that this is not true of the present, and from the very character of the ground never will be true in the future. On the contrary the increased extraction of ore by underground mining is due SOLELY to the fact that the stripping is now farther from providing the requisite daily supply of ore than ever before, notwithstanding the fact that the number of shovels employed in stripping in proportion to the quantity of ore mined by that process is more than three times what it was during the year before named, when the proportion of ore mined by steam shovels was greatest. But if we could for the moment assume as true the statements of the management in this regard, it would be very difficult to find justification for piling up from year to year of this enormous indebtedness against the corporate property for the sole purpose of preserving the proceeds of sale of the mine's product for payment of dividends. And moreover, the evil tendency of this practice is all the more flagrant in view of the fact that it is the purpose of the management to liquidate those constantly accruing burdens by involuntary partition and sale of the company's share capital and thus, whilst the corporate operations are—by the payment of liberal dividends in cash—given the appearance of prosperous activity, the relative share capital of each shareholder is being pared down in inverse ratio with each new issue of shares.

TREMENDOUS COST OF STRIPPING.

With the evident purpose of disposing of certain criticisms of this journal, it

was recently unofficially announced by one of the organs of the Utah company that there remained to be removed only 20,000,000 cubic yards of capping which, at the ratio of progress made for the last quarter, would be accomplished within five years. Assuming for the moment that this be a fair estimate of the truth (which it is not) the total cost of this work will be $12,300,000 which, added to the unpaid cost of similar work for 1911, gives a total sum of $14,760,000 to be provided for by additional issue and sale of share capital. At the present quoted market price—$55—per share this will require the issue and sale of 268,369 shares, or an increase of the present share capital and corresponding paring down of the value of relative interests of present shareholders of over 17 per cent.

In addition to the foregoing, there appears to be a debit balance of nearly $1,800,000 still carried in the form of deferred debt, due for stripping for the year 1910, and it is understood that some two and one-half million of dollars incurred in the construction of the Bingham & Garfield railroad in excess of a like sum covered by an issue of mortgage bonds, is also to be liquidated by the issue and sale of Utah shares; so that, when all these sums are covered by the issue of shares present holders, if they remain with the ship, will find themselves possessed of about 60% of their present proportionate interest.

Nevertheless, from a speculative viewpoint, we think that Utah stock bought upon recessions from the present price, and sold upon forced advances will afford fair scalpers' profits. Besides, operators dealing in this way, incur no risk of immediate loss because brokers for the pooled interests are always on hand to take any offerings which would "shade" the market in order to avert serious collapse. Moreover, the continued upward "washing" of quotations should ultimately reach an altitude that will attract the emotional public plunger, and then everybody else can sell out.

———o———

All mining camps have their periods of stagnation and low production and most all of them, worth figuring, "come back" with systematic regularity. Park City and Pioche have enjoyed a good, long snooze and, judging from reports emanating from each they are about ready to "make their presence felt" again. With 60c. silver and $4 lead these camps will not be long in making the world take notice. Park City, in particular, is rapidly being whipped into shape to more than double its present output.

GUGGENHEIM METHODS vs. "AMALGAMATED" INDUSTRIES

The mendacious character of the stuff which the subsidized press are required to publish in aid of stupendous promotion fakes, is forcibly illustrated in the following, which we excerpt from "Walker's Weekly Copper Letter, published in the Boston Commercial of February 10th:

> Ray Consolidated is now treating about 3500 tons of ore daily and earning from $70,000 to $75,000 monthly. Next Monday and thereafter its concentrates will be delivered to the new smelter located at the mill. This will effect a saving in freight and treatment charges equivalent to one and a half or one and three-quarters cents per pound of copper produced, and consequently will immediately increase the company's monthly net earnings to about $120,000.
>
> At present Ray Consolidated is treating ore that averages about 1.85% copper. This is considerably below the average of its whole deposit, which is 2.17%. The recovery in concentration is now better than 70% of all the values contained in this low grade ore, or 26 pounds to the ton. * * *

Assuming the lower sum—$70,000—stated as the monthly earnings, a net profit of 2.34 cents per pound of recovered copper is indicated, being sixty-one cents per ton of ore treated. By adding 1¾ cents a pound to the sum now received for the copper recovered from these ores which it is said will result from reduction in costs of shipment, etc., as soon as deliveries are made to the smelter now being constructed at Hayden, the net profit will be increased to 4.09 cents per pound, or $1.06 per ton of ore treated, which should afford a very satisfactory margin of profit, even if no further improvement should result from remodelling of the concentrator—which has been in process for several months past.

Immediately following the statement quoted above, Mr. Walker enters upon a discussion of the recent annual report of the Giroux Consolidated company's mines (which is a Cole-Ryan, or Amalgamated Copper Company owned property) and says:

> Wire advices from Duluth say it was announced at the meeting that 4,010,000 tons of concentrating ore, averaging 2.14% copper, is now blocked out ready to mine in the Morris-Bunker Hill mine; and that the porphyry ores fully and partially developed are estimated to aggregate 17,000,000 tons, averaging about 1.90% copper, which is approximately the same grade as those of Nevada Consolidated. In addition to this 17,000,000 tons, there is a very large tonnage of ore in the Giroux property that carries about 1% copper and which may, at some time in the future, come to have value. * * *
>
> The figures in the foregoing form a basis upon which it is possible to make a rough calculation as to the present value of Giroux stock. The 17,000,000 tons of porphyry ore should be worth $4,000,000, figuring on the basis of the recent Live Oak transaction; and the 300,000 to 500,000 tons of 3¼% smelting ore developed in its Old Glory deposit should readily yield $1,000,000 of profit.
>
> The 1,500,000 authorized shares of Giroux Consolidated are selling in the market for about $6,500,000, and, assuming the management's summary of demonstrated and assured ore is correct, these porphyry and smelting ores probably could be sold in the ground for $5,000,000. It would seem, therefore, that all the company's future prospects in the limestones, which include its deep shaft in the Alpha area, are selling in the market for $1,500,000, or only $1 for each share of its stock. * * *

Now, the report which was thus discussed by Walker, also gave details of a contract whereby from 900 to 1200 tons of Giroux ores were to be treated—concentrated and smelted—daily by the Nevada Consolidated company at its Steptoe plant for a period of five years. And it is explicitly stated in the report that "your directors have formally approved of the contract and estimate that we can make and market our refined copper for about 9½ cents a pound."

Recovery of the copper contents of the ores of Nevada Consolidated are officially stated as ranging from 71% to approximately 75%, and it is understood, and confidently hoped that the latter figure will eventually be exceeded. Practical treatment of several thousand tons of Giroux ores at its own experimental mill, gave average recoveries of 71% of the copper contents of the ore. At the latter rate of recovery ore averaging 2.14% copper would yield 31.38 pounds of copper per ton of ore treated, and deducting 9½ cents a pound to cover all costs—as stated in the report—from an assumed price of 14 cents a pound for the metal, would leave a profit of 4½ cents a pound of copper produced, showing a net profit of $1.41 per ton of ore treated. Applying this gain to the 4,010,000 tons of 2.14% ore, shows a net value of $5,662,120 derivable from the 4,010,000 tons referred to alone, OR MORE THAN $662,000 IN EXCESS OF THE VALUE CREDITED TO THE ENTIRE PROPERTY by the syndicated statement published and copyrighted by Walker and Dukelow.

And again: If we assume—and the assumption is manifestly fair—that the 17,000,000 tons of ore containing 1.90% copper, as shown in that portion of the report quoted by Walker—should yield a profit equal to that which he claims will result from the treatment of Ray ores containing only 1.85% copper—when its ores are treated at the smelter at Hayden—which profit, as we have shown, will be only 4.09 cents per pound of copper

produced and equal to $1.06 per ton of ore treated, these 17,000,000 tons of Giroux ore alone would have a total recoverable net value of over $18,000,000, A SUM EQUAL TO $12 PER SHARE UPON ITS ENTIRE CAPITAL STOCK. Or, if it were possible only to derive from the Giroux ores the equivalent of that being obtained from the treatment of Ray ores, under its present burden of excessive transportation and smelter charges, viz., "2.34 cents per pound of copper produced," or only 61 cents per ton of ore treated the net profit derivable from those 17,000,000 tons of Giroux ores would be $10,370,000, or $6.91 per share capital, leaving entirely out of account all other resources indicated in that portion of the report quoted by Walker. No comment is necessary or could adequately characterize such dastardly abuse of journalistic license.

These observations are not made for the purpose of directing attention to the probable great value of the Giroux property, as indicated by the report under discussion, nor to disparage the assumed demonstrated importance of the Ray Con. mines. On the contrary, we think the Giroux report sufficiently concise and complete as to require no elucidation by us. On the other hand we believe the Ray Con. orebodies to be of vast extent, and possessed of generous enrichment of cuprous sulphides which, with the exercise of modern skill intelligently directed (which will come in course of time) should yield liberal returns to the favored few into whose hands the shares are involuntarily finding lodgement becaues of the successive failure of the promoters' frantic efforts to effect profitable pubiic distribution.

But we beg to suggest to the managing heads of these corporations, which have so long, strenuously and unsuccessfully sought to unload their wares upon the public, that the exercise of a little conservatism in the character of the material supplied to their publicity agencies would probably be productive of better results. Nevertheless, we think it will be necessary in the end to return to the mines for any legitimate profit of the future. Evidently the public have been "stoped" to a finish.

Rapid drilling by hand is not accomplished by use of heavy hammers and forceful blows, but by hammers of proper size handled by men who know how to strike the blow that will cause the drill to cut and keep the bottom of the hole clear so that the drill is working on solid rock and not on a lot of loose fragments. This is an art, and is only learned by experience.

UNTERMYER IS CHAMPION

We present herewith an excellent photograph of Mr. Samuel Untermyer of New York City who—we think—enjoys the distinction of having received the largest fee for the smallest amount of professional work done, of any lawyer who ever practiced his profession outside of a court of justice in any state in the Union. The peculiar character of the service rendered by Mr. Untermyer is of especial interest in this day of "corporate dissolutions," and was as follows: In the early part of December, 1909, Mr. Untermyer was employed by the Boston Consolidated Gold and Copper Mining Company (of which Mr. Samuel Newhouse was then president) to negotiate a consolidation of the property of that corporation with that of the Utah Copper Company, for which service it appears that he was to receive for his services—if successful—a fee of $50,000. It

SAMUEL UNTERMYER

was also arranged with the American directors of the company that a fee of 25 cents a share should be collected from the holders of each of the 775,000 shares of capital stock of the Boston Con. company under pretense that such sum was required to cover the cost of transfer of the shares to the Utah company. This was accordingly done, and the amount —$193,333—was paid over to Mr. Untermyer, making a total sum of $243,333.

Now, it so happened that both parties to the proposed consolidation were equally anxious to arrive at terms upon which consolidation could be effected, but neither was aware of the ardent desires of the other in this regard. Mr. Untermyer, however, in the exercise of the natural instinct of a great lawyer and diplomat—which he is—soon discovered that the anxiety of the Utah people for immediate consummation of a consolidation was at fever heat, which of course rendered his task extremely easy, though he carefully guarded the fact from the Utah emmissaries. And here is where he "got in his fine work." "He would sacrifice the interests of his clients' and compel(?) their consent to the terms proposed by the Utah company on condition, first, that the Utah company should reimburse the Boston company in full the fee of $50,000 which he, Untermyer, was to receive as part compensation for his services as its attorney and counsel; second, give to him 3,200 shares of the stock of the Utah, which then had a market value of about $62 per share, or a total value of $198,400; and, third, pay to him—the "aforesaid" Untermyer—in cash the sum of $582,250, making a grand total of $1,023,983, all of which was agreed to in writing, signed by the respective parties thereto on the 20th day of December, 1909, but final consummation of the transaction was delayed by an injunction issued by a judge of a United States court in and for a district in the State of New Jersey, until about the 29th of January, 1910, when the injunction was dissolved, the consolidation accomplished and the money and stock paid over and delivered to Mr. Untermyer.

We are advised that for Mr. Untermyer's services in procuring dissolution of the Jersey injunction he was paid by the Utah company a further fee of $25,000, though we do not vouch for this latter statement; but we offer our hero upon the previous record as champion getter of "easy money."

If the price of silver would remain at 60c. or better, a price it attained during the present month, it would make a difference of nearly $800,000 to the silver-lead miners of Utah during the year, as compared with 1911, without counting any additional production that the better price would sure to bring about. But there is reason to believe that silver, like copper, is being juggled a good bit just now, and the future is hard to forecast. Maybe the rejuvenation of China, following the much-desired ending of the revolution, will bring about a wave of commercial activity and reconstruction in that country that will call for a great deal of silver, and the price will remain strong. On the other hand, there is no assurance that the manipulators of modern finance, so-called, will not pull off some scheme to upset any plan that would tend to bring silver into its own again. To help out the situation as much as possible locally, it is suggested that the Commercial Club's committee on mining communicate with Senator Reed Smoot and beseech him to get out his "urim and thummim" and do a little revelating for the good of the cause.

INSIDE AND OUTSIDE OF RAY CON-CENTRAL DEAL

In the proposed consolidation of Ray Central with Ray Consolidated mines we have a practical exemplification of "low down" and "high up" methods of finance which should make the adherents of the Guggenheim system turn green with envy. Not that there is anything startling or unusual in the proposed proceedings whereby a consolidation of these properties is to be brought about —when the past record of the participants is considered—but when we realize the fact that Ray Con. has been on the verge of collapse for almost a whole year for lack of funds with which to "remodel" its UNFINISHED concentrator, and for which reason it had been compelled to surrender to the Guggenheims its widely advertised INTENTION to build, own and operate a smelter of its own, and, after having exhausted all hope of "drill hole" development of another twenty or thirty million tons of ore upon its own property whereon to base a plausible justification for another convertible bond issue of its own in order to provide funds for its pretended imperative enlargement of its concentrator—just to think that such a "PUDDIN'" should, AT THE VERY CRUCIAL MOMENT, fall into its lap, seems almost too good to be true. But after all, consummation of the "deal" seems to present no formidable difficulties.

It appears that the inside push of the Ray Con., whose credit had become exhausted had, by "hook or crook"—chiefly the latter—secured control of a majority of the shares of Ray Central, after its managers had failed to float an issue of bonds which, if cashed, would meet all immediate needs of Ray Con. The scheme appeared all the more attractive because, with consolidation, Ray Con. would have the Ray Central with its seven and a half million tons of developed ore, and the money received from the bonds as well. And all that was required of the "Ray Con. push" in return was to have the secretary issue and deliver to Ray Central shareholders —which had become identical with the "Ray Con. push"—237,500 new shares of Ray Con. stock. With these explanatory observations, the entire proceedings become at once clear and simple; and ultimate results no doubt will prove entirely satisfactory to all concerned except the "outside" "INVESTOR," who may wish to hold his shares for promised dividends and expects to stay with his holdings until he gets his share of the profits which are to come from the Ray Central orebodies. For his benefit we submit a few figures to show how he will come out.

When the deal is closed Ray Central's allotment of shares will give them an ownership of 15.62% of the combined share capital and the outside investors' present proportionate holdings of Ray Con. will be reduced accordingly; but if he lives until all the ore is exhausted —including Ray Central—he will receive partial compensation for the initial reduction in his relative share.

It is claimed that Ray Con. alone has fully developed 78,000,000 tons of ore which, at 8,000 tons a day, would supply their concentrator at full capacity for about twenty-seven years. For convenience we may assume that this ore will yield a net profit, available for payment of dividends, of only one dollar per ton, or in all $78,000,000. At the close of the twenty-seven years Ray Central holders will have received of the profits $12,203,600 and all of the 7,500,000 tons of ore contributed by that corporation will remain intrenched.

Now we will assume that our "outside investor" is still there, and remains to the end and that the Ray Central ore will yield a net profit of $1.25 per ton, or a gross sum of $9,375,000. Of this sum Ray Con. shareholders—including, of course our friend, the outside investor—will receive in dividends 84.38% of this total sum, or $7,910,062, and the Ray Central will receive $1,465,938 which, added to the sum received from profits upon Ray Con. ore, will make a grand total of $13,669,541 received for Ray Central's ore. But, notwithstanding the foregoing disparaging analyses of the proposed combination, we advise our outside friend to take his medicine smilingly. Ray Con. needs the money in order to avert a worse calamity; and, with the consolidation consummated, we think cheap speculators can clip off profitable gains by buying on recessions from present quotations and scalping off small profits on all advances, because the "inside push" must continue to support the market by taking in all offerings which cut under advanced quotations.

WELCHES ON DIVIDENDS

According to the Salt Lake Evening Telegram, recognized as the explicit mouthpiece of the Utah Copper Company on this end of the line, no less an authority than Manager D. C. Jackling declares that the Utah Copper Company will not increase its dividend rate for some time to come, "even though copper metal prices should be firmly established at 14c. to 15c. a pound." But the paper lets the manager down easy in quoting him on this subject, because the news had already been released by some "inside interest" to the Wall Street Journal, which slaps the expectant, confiding purchasers of the company's shares as an "investment" in the following brutal fahion:

"The Utah Copper company positively has not the matter of an increase in its dividend rate under consideration, nor will it take up the matter now, nor next July, nor next October either, for that matter.

"We are running the company as a manufacturing enterprise, not a stock jobbing concern. On an ultra conservative basis the company would be paying no dividends at all at the present time, but it did not seem necessary to keep the stockholders waiting for two or three years before receiving any returns on their investments. The company has a tremendous amount of stripping to do, and it is our intention to accumulate as large a working capital to take care of the stripping operations and to enlarge and improve the plant as shall be necessary to keep it thoroughly up to date and for other improvements that may be required from time to time.

"It makes no difference if copper goes to 20 cents a pound, Utah will not increase the present dividend rate in the immediate future."

Last September, it will be remembered by readers of Mines and Methods, George L. Walker came to Utah to make an examination and report on Utah Copper. With the certain approval of the management, he gave the proposition the wildest boost that any mining enterprise probably ever received. In it the prediction was made that Utah would be made to earn, including the contributions of Nevada Consolidated, $7 a share on 13c. copper and $9 a share when copper should sell at 15c. NOW WE ARE TOLD BY THE COMPANY'S OFFICIALS THAT NO ATTEMPT WILL BE MADE TO INCREASE THE $3 A SHARE RATE FOR A LONG TIME TO COME, even though, if reports are to be given credence, the company finds a ready sale for all the copper it can produce at better than 14c. a pound.

The Wall Street Journal's authority is made to say that the company "on an ultra conservative basis would now be paying no dividends at all." The interview brings out other admissions that are equally interesting as showing that ALL THE TIME Mines and Methods has been fairly presenting the real condition of affairs as they exist; that the

company NEVER HAS BEEN DOING WHAT IT CLAIMED and that it is still figuring on bringing its plant up to date; that it still has a tremendous amount of stripping to do and that a large reserve fund must be accumulated to meet these requirements.

It must be galling to the management to be compelled, at the end of seven years of strenuous work, with millions of money at its disposal, to stand for a statement to the public which shows how utterly futile its efforts have been; to what little purpose these millions have been expended, particularly when the entire burden must rest on the shoulders of a manager who has had absolutely free rein and who has been paraded by his associates as "the greatest engineer in this or any other country."

COPPERETTES

Cables from Paris indicate that the French are in no particular hurry to give Ray Consolidated and Chino "standing room" in the Coulisse, or Curb department of the Paris Bourse. Wonder what the trouble can be?

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Have you ever noticed how regularly the "sales" of Utah Copper on the New York Stock Exchange just about equals the sales of all other copper stocks quoted. Once in a while Ray and Chino will be given a lift, but not often. It is nothing to see "sales" of Utah Copper run up to 6,000, or even 16,000 shares, when Associated Press reports declare the market is stagnant. The strength displayed by Utah Copper is something wonderful to behold.

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The following dispatch to a local paper is quoted because it helps to emphasize what an "ideal steam-shovel proposition" Utah Copper really is:

BINGHAM, Feb. 23.—Edward Leaton was killed here yesterday by an embankment caving in at the Utah Copper mine. Leaton was a steam shovel engineer and was working on the highest level of the mine. The embankment caved in, almost burying the steam shovel.

A few days before that a train got away from the crew on Copper Belt high line, which connects with the steam shovel pits. In this accident men were killed and others maimed, while cars were reduced to kindling and the locomotive and some of the cars rolled down the mountain side wrecking buildings in the town of Bingham. There is simply no denying the fact that steam-shoveling conditions at the Utah Copper are ideal.

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When the third quarterly report of the Utah Copper Company for 1909 was issued, in November of that year, the management apologized for not having its stripping advanced to a point where underground mining could be entirely dispensed with. The report said: "The tonnage of underground ore mined was further reduced during the quarter to 14% of the total ore mined. At the close of the quarter underground work had been entirely discontinued, with the exception of a moderate amount of development work, and IN THE FUTURE ALL BUT AN INSIGNIFICANT PORTION OF THE TONNAGE, which will come from development, will be extracted by steam shovel mining." After discussing briefly what was being done in the matter of stripping, the cost of that work, etc., the second following paragraph winds up with these words: "We direct attention to this feature in order to indicate the distinct advantage and economy of our being NOW ABLE TO PERMANENTLY DISCONTINUE UNDERGROUND MINING, as above discussed."

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Copper is the most highly contraband article in war next to gunpowder, and the essential part of preparation in any international strife is that copper be gotten into the country. This is the real reason why large American financial interests are willing to neglect American railroad and industrial shares and take up with "coppers."—Boston News Bureau.

In the parlance of the gambler that's "getting down to cases." And on its face it is gross deception. No one knows better than the News Bureau that American financial interests are NOT "taking up with the coppers" to any appreciable extent; the wish is father of that thought. Only once before have we heard of such an argument in support of fake copper stock buying as that Europe is getting ready for war and is afraid that it will run short of copper for the manufacture of cartridges—as told in a paragraph preceding the item quoted above—and that was several years ago in this city when President Keith, of the Walkover Shoe Co., explained at a love-feast given in his honor by the management of the Majestic Copper Company, that he was buying into the proposition because of the amount of copper used in his business; he was able to see where a tremendous saving could be affected by getting the material direct from the mines to make the copper shoe nails or tacks absorbed by his factories.

AUSTRALIAN RADIUM

The experimental production of marketable radium bromide indicates the further development of what may prove one of the most important Australian mining industries of the future. Within the next few days the shareholders in the Radium Hill Company will meet in Sydney to receive a report setting forth the financial position of the company, as well as the facts connected with the establishment of treatment works at Woolwich, on the Parramatta river. The financial position on June 30 shows that on the books closing there was a credit balance of £1,251 12s. 4d., after allowing for outstanding liabilities. The works will be under the management of Mr. S. Radcliff, formerly director of the Bairnsdale School of Mines, the gentleman who treated 31 tons of radium ore sent to Bairnsdale from the company's mine at Olary. Regarding the results obtained from this ore, the directors remark:

"This ore has been treated and, as will be seen from Mr. Radcliff's report, under difficulties. As far as Mr. Radcliff can judge from the results of treatment to date, he anticipates that the company will receive, when treatment has been completed, not less than £1,800, and not more than £2,500, worth of radium from the whole parcel, which is equal to anything between £60 to £80 per ton of crude ore."

According to figures and information supplied by Mr. Radcliff, it is anticipated that the annual expenses will not exceed £15,000, and it is expected that in the first twelve months not less than 2 grammes of bromide will be produced, worth (according to the latest reported sale of radium bromide—viz., £15,000 a gramme), £30,000; so that there should be an annual profit to the company of at least £15,000 from the radium alone. It is believed that in addition about £7,500 worth of uranium oxide (the production of which is included in the above estimate of costs) will be recovered, thus making the profit £22,500. With increased plant—at present there is only one furnace—there would be increased production. On October 10 Mr. Radcliff notified that he had "produced radium in marketable form." Recently Mr. Radcliff visited the mine at Olary, and estimated that between Nos. 1 and 2 shafts there were 5,600 tons of ore, containing 162,400 lbs. of urnaium oxide, and 20.8 grammes of radium as bromide. In concluding his report, he says: "It is of interest to note that the latest estimate of the total amount of pure radium salts which have ben prepared up to the present time is ten grammes. Your property, therefore, contains in this one block of ore alone more than twice the world-existing stock of pure radium bromide."—Sydney corespondent London Mining Journal.

LEACHING APPLIED TO COPPER ORE*

Fifteenth Article Reviewing Results Accomplished, With Special Reference to Lixiviation With Solutions Formed by Passing Electric Current Through Liquors Containing Chlorides

By W. L. AUSTIN.†

The passage of the electric current through an electrolyte consisting in whole or in part of a solution of sodium chloride, and then employing the said solution for leaching copper from its ore, constitutes a means of obtaining solvents upon which have been based a number of patents issued during the past twenty five years.

It matters not in what manner the original lixiviant may have been prepared, one and all solutions containing chlorides of the alkalies, alkaline earths, or iron, after they have passed over roasted ore and through electrolytic vats a couple of times, are for all practical purposes equally efficient solvents under equal conditions. In every case the active agents are ferric and cupric chlorides, with which may be associated under certain conditions free chlorine, hypochlorous salts, and other combinations containing chlorine. Solutions of chloride of sodium, or of ferrous and cuprous salts mixed with chloride of sodium, after being subjected to an electric current of suitable density, and allowed to act on copper ore, will take up metals such as copper, silver, lead, etc., present in the ore, and the resulting liquors will possess practically the same leaching qualities, at the same temperature and per unit of active reagent, after the contained copper has been deposited from them through electrolysis.

The original lixiviant may be prepared by electrolyzing a simple solution of common salt (NaCl), (whereby chlorine and various compounds of chlorine and oxygen are produced, according to conditions existing in the vats when applying the current), or a mixture of ferrous sulphate and salt may be treated in the same manner, producing ferric chloride, etc., or recourse may be had to some more complicated and expensive method of obtaining the desired end, such as first electrolyzing a sodium choiride solution in a separate vessel, using iron anodes. Inasmuch as the essence of all such methods is regeneration of the solvent-liquor, that is, re-use of the solutions after the copper has been removed from them in the electrolytic vats, the manner of preparation of the original lixiviant has no practical significance. The preparation of fresh solutions for each batch of ore treated being too expensive in most cases, the choice of a method for obtaining the original lixiviant will of course depend upon the cost of raw materials used. The treatment of raw or roasted ore by an electrolyzed solution of sodium chloride is all that is necessary to furnish the desired lixiviant.

SIEMENS & HALSKE FURNISH PRECEDENT.

Messrs. Siemens & Halske of Germany, one of the most important and enterprising industrial firms of Europe, were among the first to take up the metallurgical treatment of copper-ore with electrolytically prepared solutions. This firm employed both sulphate and chloride lixiviants in the processes introduced by it, as is evidenced by letters patent granted to Werner Siemens. The early experiments made by the firm upon a small scale were so successful that a brochure was issued in 1891 describing the methods in detail, and the firm demonstrated its confidence in the practical value of the process by installing a plant at its own copper mines in Russia. This way of testing the economic worth of a new process is the right one, for no new metallurgical method has a demonstrated value until it has been placed in competition upon a working scale with established processes. It cannot be assumed that tests of processes made in a comparatively small way in laboratories are going to prove equally successful when applied commercially.

The characteristics of the Siemens & Halske process have been described in a former article and need not be repeated here; but it is thought desirable to again call attention to the electrolytic treatment of chloride solutions by Siemens & Halske, illustrating as it does the fact that more than twenty-five years ago lixiviants for copper ore were obtained by electrolyzing solutions containing sodium chloride.

In proof of this statement reference is made to United States Patent No. 415,576, dated November 19th, 1889, granted to Werner Siemens, covering the invention referred to below. On October 30th, 1886, letters patent for the same invention had already been granted by Italy.

In the specifications to patent 415,576 it is stated that the invention "consists in the following process: subjecting a solution of a salt of the metal which it is desired to obtain and of a ferrous salt to the action of a cathode-plate, whereby the desired metal will be deposited and the element or elements in chemical combination therewith will be liberated; subjecting the outflowing liquid to the action of an anode-plate of insoluble material—such as carbon, platinum, or lead, or of a plate covered with platinum—the said cathode plate being separate from the anode-plate by a non-metallic diaphragm which is impervious to the solution, but which allows the electric current to pass, whereby the free elements liberated by the cathode-plate will be caused to enter into chemical combination with the ferrous salt, converting the latter into a ferric salt, and, finally, lixiviating ore containing the metal to be extracted with the solution of ferric salt obtained from the anode-plate, whereby the metal will be dissolved and the ferric salt reconverted to a ferrous one, and a solution obtained with the same chemical constituents as that first passed under the influence of the cathode-plate, or, instead of subjecting the electrolytic solution to the action of a single pair of plates only, several anode and cathode plates may be used, and the solution subjected successively to each, as will be hereinafter more fully described and claimed."

SULPHATE SOLUTION PREFERRED.

Mr. Siemens, judging from the text of his patent specifications, evidently preferred to employ sulphate solutions in lixiviating copper ore, but the specifications to which reference is made also cover "an analogous method for the electrolytical separation of copper" by chlorinization, as witness the following: "The electrolytical liquid then consists of cupric chloride ($CuCl_2$) and ferrous chloride, ($FeCl_2$), from which in the galvanic cells copper and ferric chloride (Fe_2Cl_6) are obtained according to the following equation: $CuCl_2+2FeCl_2=Cu+Fe_2Cl_6$. The ferric chloride thus formed possesses the power of converting sulphide of copper not decomposed by roasting into cupric chloride, ($CuCl_2$),

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and also of converting, with the aid of a solution of chloride of sodium, (NaCl), cuprous chloride (Cu_2Cl_2) into cupric chloride. In either case ferric chloride is reduced again to ferrous chloride. Thus, also, in this process the solution is regenerated so that it becomes again suitable for electrolysis, and no polarization takes place."

It is evident from the foregoing that in the Siemens patent, (which expired five years or more ago), the patentee pointed out the application of an electrolytically prepared chloride solvent in the treatment of copper ore containing oxides or sulphides of that metal, which solvent was obtained by electrolysis of a solution containing sodium chloride and salts of iron. Assuming that at the start the solution contained only sulphates derived from leaching a roasted copper-ore with water, the addition of sodium chloride for the purpose set forth in the patent specifications would produce chlorides of iron and copper. Therefore the regenerated lixiviant resulting from passing the original lixivium once through the electrolytic cells, would contain ferric chloride, accompanied by free chlorine and the various chlorine salts generated by electrolysis of solutions in which sodium chloride is dissolved, or which contain iron chlorides and other salts naturally present when a copper-ore is leached.

Claim 1, in the Siemens specification reads: "The process which consists in lixiviating ore with a solution containing a ferric salt, subjecting the resulting ferrous solution at the cathode of an electrolytic cell to the action of a current of electricity, whereby the metal in solution is deposited, then subjecting the remaining liquid to the oxidizing action at the anode, whereby the ferrous is reconverted into a ferric solution, which solution is again used to lixiviate ore."

When a solution containing the chloride of any metal is used as a lixiviant for copper-ore, as described in the Siemens specification, and when antecedent to electrolysis sodium chloride is added to the liquor to dissolve any cuprous chloride formed, or for any other purpose, then there is established the fundamental principle for the preparation of a chloride lixiviant through electrolysis of a chloride of sodium solution, and any other method of preparing a similar lixiviant only constitutes a variation of the basic principle without affecting the essential point at issue.

HOEPFNER DEVELOPS THE SAME IDEA.

Carl Hoepfner was another who made use of a chloride lixiviant in leaching copper ore. His claims to novelty are set forth in United States Patent No. 507,130, issued October 24th, 1893. The same process was patented in Great Britain April 23rd, 1885.

In his patent specifications Hoepfner states: "I first form a solution of cupric chloride ($CuCl_2$) by means of a solvent of cuprous chloride and chloride of silver, as for instance, by dissolving the cupric chloride in a saturated solution of chloride of sodium, calcium, or magnesium. The ore, matte or pyrites are reduced preferably to a pulverulent condition and are then leached out with the cupric chloride solution, whereby the latter is converted into a cuprous chloride solution. * * * The silver may, however, be extracted from the cuprous chloride solution, and hereinafter called the electrolyte, simultaneously with the copper by electrolysis. To this end the electrolyte is rapidly passed through series of anode and cathode cells of an electrolytic apparatus hereinafter called the electrolyzer, whereby silver only will be deposited at the cathodes first brought into contact with the electrolyte, while the copper will be deposited at the succeeding cathodes, these metals being deposited in the order of their position in the electrolytic series. In this electrolytic separation of the copper and silver the electrolyte is supplied to the anode and cathode cells in two separate streams, the cells of unlike name being separated from each other by a diaphragm impermeable to the electrolyte but affording free passage to the electric current. As stated the metals, silver and copper, will be deposited at the cathodes, while the electrolyte at the anodes will be converted by the chlorine liberated, from a cuprous to a cupric chloride solution, which is afterward mixed with the solution flowing from the cathodes for use as a leaching agent in the treatment of fresh materials, the solution flowing from the cathodes being substantially free from metals. The chlorine liberated at the anode acts in *statu nascendi*, resulting in the generation of electro-motive force that is not only favorable to but assists in the separation or extraction of the metals and conversion of the electrolyte. * * * Inasmuch as cupriferous ores contain more or less iron which may enter into solution in the preparation of the electrolyte, the repeated use of the regenerated cupric chloride solution would result in an accumulation of an excess of iron, which is undesirable. This is also avoided by treatment of the electrolyte with carbonate of lime. The removal of the iron may also be effected by injecting air or oxygen into the electrolyte, which results in the formation of oxychloride of copper that acts as a precipitant for the oxide of iron, but a small quantity of copper, comparatively speaking, being necessary. * * * I prefer to employ diaphragms made of parchment paper reinforced on one or both sides by textile fabric or leather, veneer, gelatine, asbestos, or the like, as described in my application for Letters Patent of the United States, Serial No. 378,616 filed January 21, 1891."

Thus it is seen that Hoepfner prepared a lixiviant for leaching copper from its ore by dissolving cupric chloride in a saturated solution of sodium chloride, passing the said lixiviant through the ore, and then electrolyzing the resulting lixivium. Of course, after the copper had been removed the regenerated liquor was practically identical with the Siemens solution, but Hoepfner thought an excess of iron chlorides to be detrimental to the operation—in any event, he preferred to work with cupric chloride instead of the ferric salt. Therefore he tried to remove as much of the iron as possible by the use of carbonate of calcium. If he had succeeded in removing all the iron his electrolyzed liquor would have contained as its active agents cupric chloride, dissolved chlorine, and the different combinations of chlorine and oxygen, etc., which are produced under such circumstances according to conditions existing in the electrolytic vat. Except for the fact that Hoepfner attempted to remove the iron, and intentionally left some cupric salts in the electrolyzed liquor, there was no essential difference between the two solvents: the efficiency of both depends largely upon the dissolved chlorine and chlorine compounds.

USE OF CALCIUM CHLORIDE ADVOCATED.

As shown in the above specifications, Hoepfner, among other chlorides, contemplated the use of calcium chloride in his process. The advantages of the calcium salt are emphasized by Charles S. Bradley, (United States Patent No. 1,001,562), because, in addition to other good qualities, it assists in rendering the waste products of the operation insoluble and facilitates filtration. It is inexpensive, readily obtained or manufactured in the vicinity of the work, and easily regenerated for continuous use in the process.

In the Bradley process the ore is roasted to convert the copper and iron sulphides into copper sulphate and ferric iron. Then calcium chloride is added, changing the sulphate into chloride: $CuSO_4+CaCl_2=CuCl_2+CaSO_4$. Here it will be observed that the copper content is in soluble form, whereas the calcium sulphate which does not contain any values is insoluble, and hence precipi-

tates. In other words, calcium chloride solution takes up only the values, as distinguished for example from a sodium chloride solution which in the reaction referred to would produce sodium sulphate which, being soluble, would remain in the carrier. The complications arising from the presence of soluble substances other than the values in the carrier, are to this extent eliminated.

The employment of calcium chloride presents another important advantage in the subsequent operations. The solution loses calcium, which goes into the formation of the calcium sulphate as above indicated: the chlorine, however, is conserved in the copper chloride. Regeneration of the carrier, and precipitation of the values in a highly concentrated form, may thus be accomplished in a simple and rapid manner by introducing calcium carbonate, which is an inexpensive substance: $CuCl_2+CaCO_3=CuO+CaCl_2+CO_2$.

Furthermore, it is found that the difficulty which is usually met with in filtering, settling or otherwise separating solids from liquids in operations of this kind, is largely done away with, for by maintaining calcium chloride in the solution clogging is prevented and the flow of the liquid through the separating medium is facilitated. Oxychlorides of iron and copper, which, if permitted to remain, would clog the oxidizer towers, are removed by hydrochloric acid generated in another part of the operations: $Cu_2Cl_2O+2HCl=2CuCl_2+H_2O$.

In the Bradley process the final cupriferous product is copper oxide, which apparently it is the intention of the inventor to smelt. There is no electrolytic treatment involved, but the method outlined has so many points in common with Hoepfner's process that mention is made of it at this point for the sake of comparison. The apparatus indicated in the drawing accompanying the patent specifications is designed for continuous treatment of the cupriferous material. Stationary vats and decanting vats are particularly avoided as necessarily intermittent in operation and limited in capacity: the use of vacuum filters is indicated. The solution of calcium chloride acts both as a solvent and as a carrier, circulating through the apparatus from beginning to end, and when regenerated it is returned to the cycle of operations without change of state. The chloridizing of practically the entire values takes place in the solution drum and not in any preliminary roasting process, and there is no tendency to overload with chlorine salts requiring expensive processes of elimination. The solution is automatically restored to proper condition, with calcium chloride in excess of the amount normally required for taking up the values. No additions of the salt are necessary, other than the amount required to make up for the slight waste that may occur. The patent specifications are voluminous and contain matter of interest to those engaged in the hydrometallurgical treatment of copper ore. There are eighty-seven claims to novelty of idea.

THOMAS W. LAWSON IN HYDROMETALLURGY.

The Bradley process is presumably the one referred to in the 252-page pamphlet issued by Mr. Thomas W. Lawson about three years ago, in which he made mention of a wonderful copper process that was about to be brought before the public. Mr. Lawson stated in the aforesaid pamphlet: "Three men, two of my associates and myself, have invented and perfected and are at the present time commercially operating a process which solves the copper problem which for hundreds of years has balked the scientists and inventors of the world, and solves it in a way which is marvelously simple in its commercial practicability. * * * In the solving of this great problem the same men who made the invention have carried it through the experimental stages, and then the commercially experimental stages, and then into the complete commercial plant, where the layman, without knowledge of chemistry or mining, in an hour's investigation can grasp not only what the invention accomplishes, but its value to the world, and its unprecedented earning possibilities—and all this without the world, or even those interested in the copper industry, suspecting what these men were attempting. To realize the difficulty of this accomplishment it must be borne in mind that before it could actually be proved that a process for the extraction of copper from the ore would work successfully upon a commercial scale, it was necessary to secure a plant; and to test such a plant, to obtain hundreds of tons of different varieties of copper ore, which could only be procurred from the different going mines. * * * From research Mr. Bradley proceeded to the laboratory; from the laboratory to an experimental plant; the experimental plant was dismantled and a commercial plant erected; in the large plant hundreds of tons of different ores from different mines in different parts of the country have been treated and are being treated today, and the completed commercial operating plant is indisputable proof that Mr. Bradley * * * has solved the copper problem, and in a wonderfully simple and effective manner."

It was proposed to capitalize The Process Company on a basis of $90,000,000—900,000 shares of common stock at $100. In addition there were to be 300,000 shares of preferred stock at $100, and $30,000,000 in 8% bonds, convertible into 8% preferred stock. The pamphlet reads like a tale from the Arabian Nights, but no hint as to the nature of the process was given the public until the recent appearance of the Bradley patent.

GREENAWALT ALSO ELECTROLYSES SALT SOLUTIONS.

Greenawalt, (United States Patent No. 973,776, dated October 25th, 1910), has also made use of the same basic idea, (the electrolysis of a solution of common salt), to obtain a lixiviant for treating copper-ore. Greenawalt states in his patent specifications: "The first step in the chemical process consists in combining chlorin, generated from metal chlorids by electrolysis, with sulphur dioxid produced by roasting concentrates or sulfid ore, in the presence of water, to form acid."

The Greenawalt process has already been described in Mines and Methods, Vol. III, pages 339-342, and reference is made to it here only for the purpose of pointing out the analogy with the foregoing methods mentioned, for in this process the solvent used is again prepared by electrolyzing a solution containing common salt, to obtain chlorine compounds which here also constitute the active agents present in the lixiviant. The Greenawalt process is an advance over those previously referred to, in that sulphur-dioxide is passed into the saline solution, thereby producing sulphates which in turn react with the sodium chloride present to form other chlorides and hydrochloric acid. The Greenawalt process is essentially an electrolytic process, and sodium chloride is the only chemical substance which it is necessary to provide in addition to those, (Fe, SO_3, etc.), derived from the ore itself. Sulphur-dioxide obtained by roasting sulphide-ore is the reagent consumed, for theoretically at least there should be no loss of chlorine. If the ore is roasted, salt may be added during the roasting, in which case lixiviation of the roasted pulp with water, and electrolysis of the lixivium to deposit the contained copper, affords the means for regenerating the lixiviant necessary to continue the cycle of operations. The introduction of sulphur-dioxide into the bath, effects constant reproduction of hydrochloric acid and is an important improvement upon preceding processes. However, in all the cases mentioned, (except the Bradley process), the essential feature of the several methods is regeneration of the active chlorine compounds of the lixiviant through electrolysis of the lixivium derived from the ore. It is therefore a self-evident fact that the manner in which the original solvent liquor is prepared, and the style of apparatus in

which the operation is carried out, are merely details, and do not materially affect the basic principle involved.

ABOUT LEACHING VESSELS.

It has long been recognized that the chemistry of wet-treatment methods applicable to copper-ore is much further advanced than are the mechanical features of the processes advocated. Whereas there are available numerous solvents for mineralized copper, suitable refractory substances out of which vessels might be constructed of sufficient size for commercial use, able to withstand the prolonged action of mordant liquors, are not conspicuous. In cyanidation of gold and silver ore vessels of requisite size for economic handling of large quantities of pulp are made from materials which would not withstand for one day the action of electrolyzed chloride-solutions of suitable strength for use as lixiviants of copper ore. Wooden apparatus has not proven satisfactory: all inexpensive metals in common use and metallic alloys are speedily attacked: cement structures disintegrate. Earthenware and glass vessels, of large dimensions, are difficult to construct and liable to break. The lack of suitable vessels such as might be employed for operations on an extended scale, has been a serious obstacle in the path of hydrometallurgy of copper. However, experiments involving a new principle of construction are being made which hold out the hope of overcoming difficulties heretofore encountered; but the apparatus has not yet been subjected to the test of continuous use for a sufficient period to form an accurate opinion regarding its merits. At present it would appear probable that vessels of any reasonable size may be constructed from cheap material which will withstand the corrosive action of any lixiviants likely to be employed in leaching copper from its ore.

With regard to the type of apparatus best adapted for leaching purposes, one point seems to be fairly well established by experience: agitation produced by mechanism placed WITHIN the vessel in which the leaching is being carried out, should be avoided when making use of chlorine solutions. Such contrivances are quickly rendered useless through attrition and corrosion. They are applicable to intermittent laboratory work where they can be carefully watched, but cannot be relied upon in commercial operations.

It is desirable where possible to agitate a pulp with the lixiviant in effecting extraction of metallic salts, and for this purpose revolving drums have been repeatedly used. If the reaction can be quickly carried out, continuously operating drums, (such in which the pulp and lixiviant continuously pass in at one end and out at the other), have manifest advantages. Such drums might be arranged in series, one below the other, where reactions call for more time than that available in a single drum. However, as a general thing, sizing the pulp, and treating the coarser part in large vats by a solution-circulating system placed outside the vats, will answer in most cases. The fines may be handled separately by agitation, if necessary; but upward percolating solutions are very effective.

[NOTE.—In our last issue (January, 1912) a typographical error occurred in relation to the table at bottom of page 383. "Grams per 100 cc. solution" should read: Grams per 1000 cc. solution.]

McQUISTEN TUBE MILL

A staff correspondent of the Mining and Engineering World gives the following interesting account of the successful installation and operation of the McQuiston tube mill process at Mullan, Idaho:

"The new McQuisten tube process, for the recovery of zinc and lead slimes, has been demonstrated to be a success at the Morning mine, owned by the Federal Co., at Mullan, Ida. This is the first tube mill of its kind to be placed in practical operation. The machines are manufactured by the American Direct Concentrating Co., of Salt Lake City, Utah. This company has, of necessity, erected experimental plants on different classes of ore, but the Morning mine plant at Mullan is the first to be installed under actual 24-hour working conditions, for the purpose of saving ore of commercial value, from material which, for many years, has been delivered to the tailings piles as waste. Many experiments have been tried on the ore from the Morning mine during the past score of years, some of which have more or less perfected the process of milling and concentration, and have resulted in many important changes in the Morning plant.

"The ore from the mine is of a nature which does not lend itself readily to common concentration methods, the galena ore being mixed with a heavy spar, zinc, iron and barium. The fine grinding necessary reduces much of the material to pulp, or slimes, and in this much of the silver values, and all of the zinc, are lost in the tailings. The mine had never shipped any zinc ore until the McQuisten tube mill was installed. This process has been a success from the start, which is evidenced by the fact that the company is now erecting a new addition to the mill, in which will be installed a new 100 ton unit.

"The present plant is of 100 tons daily capacity, and from this feed is producing 8 tons per day, which product, as it comes from the tubes, will assay 48% zinc, 5% lead and from 6 to 7 ozs. silver per ton. The feed as it comes from the Wilfley tables and Frue vanners will average about 8% zinc and 2% lead, with very small values in silver.

"The tube stands for this mill are of strong and neat construction, being made of ¾-in. iron tubing, and occupy but little space, each stand covering actual floor space about 10 by 4 ft. 8 ft., and can be crowded close together, if necessary, with just walking space between each unit. The cost of the plant is about $125 per tube. There are 16 stands of tubes, 8 tubes in each stand, in a plant of 100 tons' capacity, each stand costing about $1000 or a total of $1600. A 35-hp. electric motor furnishes all the power required for the operation.

"The process is in direct opposition to the concentrating method employed in ordinary milling, where the heavy material sinks to the bottom and the lighter residue is carried off by water. In the McQuisten process the mineral floats off ahead of the waste, which latter is carried on the bottom to the waste discharge.

"The first process is the dewatering of the slimes by a Dorr classifier and an Akins screw classifier. The ore is then treated to an acid bath, 50 lbs. of sulphuric acid being used in a 24-hour run. The resulting material is then mixed with water containing a small percentage of soft soap and coal oil, which the mill men call "the dope." The amount of the two materials used in a 24-hour run are as follows: 1 lb. soft soap and 1 gal. coal oil. After receiving the "dope" the feed proceeds to the tubes, where it passes through a series of 4 tubes, all of which discharge their proportion of clean ore at each end.

"The feed is kept in agitation by a heavy quadruple screw thread, with which the inside of the tubes are equipped. These threads serve to carry the material out of the water, up the sides of the tubes, and turn it over on the surface of the water, where a portion of the sulphide particles of the ore are caught and float over the discharge, while the balance of the feed sinks, to be caught by the next thread, and the process repeated so on through the entire length of the tube, a distance of six feet. The resulting product is clean ore of mixed lead and zinc, which gives the assay returns above quoted. It is then fed to a James table, where practically a clean separation is made of the lead and zinc, the lead going into the first-class discharge, while the zinc being the lighter material, takes the place of what would be the waste from ordinary mine feed. The product is sent to smelters."

SULPHURIC ACID MAKING AT DUCKTOWN, TENN.

By WILBUR A. NELSON.*

Tennessee can boast of having located within its borders the two largest sulphuric acid plants in the world. These two plants are situated in the Ducktown copper mining district, which is in the southeast corner of the state. They belong to the Tennessee Copper Co. and the Ducktown Sulphur, Copper and Iron Co., and they utilize in the making of the sulphuric acid the gases which come from the smelting of the copper ores. These gases are high in sulphur dioxide.

Under normal conditions the flue gases have approximately 3.5 per cent sulphur dioxide, 3.5 per cent carbon dioxide and a trace of sulphur trioxide, and a range in temperature of as much as 200 degrees C. every 10 minutes. From this it would readily be seen by anyone conversant with the reactions of this process that a chamber acid plant of ordinary design would be entirely inadequate to meet such varying conditions. Besides this the flue dust, which carries a large per cent of zinc in the form of impalpable sulphates and oxides, presents a problem in itself which, unless eliminated, will clog up the system of pipes. Moreover, the zinc itself is a valuable by-product to be recovered. It is in special provisions to meet these conditions that the two plants in the Ducktown district differ from the ordinary chamber acid plant.

CHAMBER PROCESS OF ACID MAKING.

In this process the manufacture of sulphuric acid consists in several stages. The first stage is the burning of the pyrites (FeS_2), which contains the sulphur. In this burning the iron is changed to iron oxide (Fe_2O_3), and the sulphur combines with oxygen from the air to form a gas, sulphur dioxide (SO_2). The reaction is $2FeS_2+11O_2=Fe_2O_3-4SO_2$. The second stage is in the combination of more oxygen with the sulphur dioxide to form sulphur trioxide, which is accomplished by the action of the oxides of nitrogen upon the sulphur dioxide. These oxides of nitrogen act as a carrier of the oxygen to the sulphur dioxide. They are derived from nitre ($NaNO_3$) by mixing a solution of this salt with sulphuric acid and subjecting the mixture to the hot sulphur dioxide contained in the furnace gases.

The third stage is the mixture of the necessary amount of water in the form of steam to the sulphur trioxide. This last stage takes place in the leaden chambers.

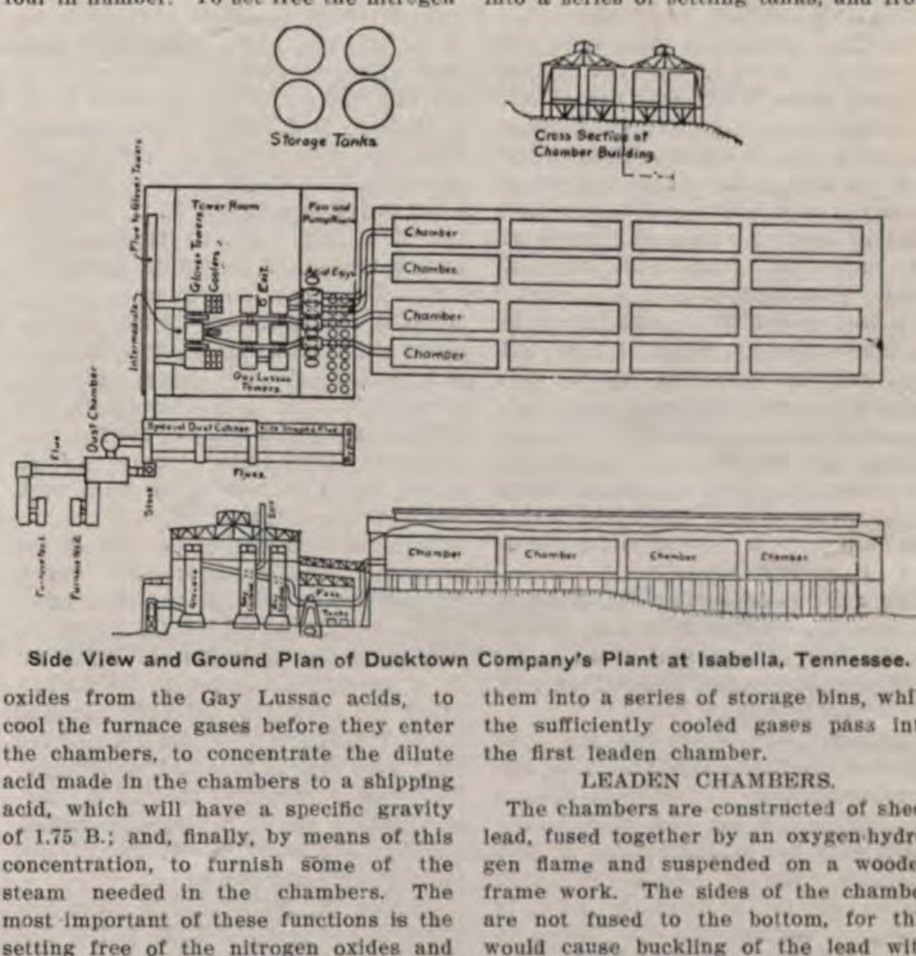
The raw materials used are pyrites (FeS_2), nitre ($NaNO_3$) and water (H_2O). Most of the pyrites used in this locality come from Virginia, Spain and Cuba in the form of fines and lumps. The Virginia fines will average only 42 per cent sulphur, while the ore, which comes from the Rothchilds' mines in Spain, give 50 per cent sulphur.

GLOVER TOWERS.

The functions of the Glover towers are four in number. To set free the nitrogen oxides from the Gay Lussac acids, to cool the furnace gases before they enter the chambers, to concentrate the dilute acid made in the chambers to a shipping acid, which will have a specific gravity of 1.75 B.; and, finally, by means of this concentration, to furnish some of the steam needed in the chambers. The most important of these functions is the setting free of the nitrogen oxides and their concentration so that they can be applied again at the top of the Glover tower. Incidentally, some acid is formed in this tower, for any sulphur trioxide present is absorbed at this point.

The gases from the nitre pots go directly to the Glover tower, which they enter at the bottom and ascend through a checker work of chemical bricks set in sulphur. Ordinary dimensions for such towers are 30 ft. in height by 12 ft. in diameter. The Gay Lussac acid and weak chamber acid (specific gravity 1.6) are mixed at the top of the tower, and are fed by a suitable distributing apparatus into the tower. This apparatus consists of a main pipe, which runs across the top of the tower and distributes the acid into cross-channels, which in turn feed the acid into leuts. There are from 50 to 75 of these leuts, through which the acid enters the top of the tower in small streams. They also act as a hydraulic seal to prevent the escape of the ascending gases. This arrangement causes the acid, which falls as a finely divided spray, to come in direct contact with the hot ascending gases in the best possible manner, and cools the gases, besides condensing the falling sulphuric acid, and producing a small additional amount of acid.

From the Glover tower the acid runs into a series of settling tanks, and from them into a series of storage bins, while the sufficiently cooled gases pass into the first leaden chamber.



Side View and Ground Plan of Ducktown Company's Plant at Isabella, Tennessee.

LEADEN CHAMBERS.

The chambers are constructed of sheet lead, fused together by an oxygen-hydrogen flame and suspended on a wooden frame work. The sides of the chamber are not fused to the bottom, for this would cause buckling of the lead with the changes of temperature. Except for this, the chamber is one continuous piece of sheet lead. The bottom is, therefore, made like a pan, about 8 in. wider than the sides, and with flanges, which extend up about 22 in. The acid collects in the bottom and forms a hydraulic seal, thus preventing the escape of the gases. On the inside sides of the chambers are placed lead channels about 8 ft. long, sloping from both ends to the middle of the trough, where a small pipe leads to

*State Geological Survey of Tennessee.

the outside. Through this pipe the acid drips into a glass tube in such a manner that the fresh acid goes into the bottom and the old acid overflows at the top. In this is placed a Baume hydrometer to measure the strength of the sulphuric acid.

The sulphur oxides, together with the oxides of nitrogen, enter the chamber at a temperature near the boiling point of water. Steam is injected through nozzles in the top of the chamber, and the acid-making process is complete.

From the first chamber the gas is carried by steam suction into an intermediate leaden tower filled with chemical brick, and from the top of this tower it goes into the second chamber. In this manner the gas is carried through the entire series of leaden chambers. From the last chamber the gases go to the Gay-Lussac tower.

GAY-LUSSAC TOWERS.

The main purpose of these towers is the recovery of the nitrogen oxides from the spent gases before they escape into the atmosphere. This is brought about by feeding part of the concentrated acid from the Glover tower into the top of the Gay-Lussac towers, which are made of lead, supported on a steel frame work and lined and filled with chemical bricks. This checker work of chemical brick insures contact between the acid, which is cooled to render it more efficient, and the ascending gases. This cooled acid from the Glover tower absorbs the nitrous anhydride (N_2O_3) and nitrogen tetroxide (NO_2 or N_2O_4), but not the nitric oxide (NO) of nitrous oxide (N_2O), which escape. Only acid with a specific gravity of more than 1.5 can be used in this absorption.

The acid, after leaving the Gay-Lussac towers, goes directly into the Glover towers, where it is relieved of the oxides of nitrogen, and passed into settling vats, and then into storage tanks.

The acid plant, which has just been described, is of the type that most fertilizer companies in Tennessee operate for their private use, and whose entire output they use in the making of acid phosphate. But at present we have another source of sulphuric acid in Tennessee, mainly from the Tennessee Copper Co. of Copper Hill, Tenn., which started a plant in 1906, and the Ducktown Sulphur, Copper and Iron Co. of Isabella, which started a plant in 1908. Both plants were started for the twofold purpose of relieving the damage done to vegetation in the surrounding country by the sulphur fumes, and to utilize a valuable constituent of the ores that had heretofore gone to waste.

These two plants are similar in their essential features to the plant already described, the greatest difference being in the source of gas supply, the control and regulation of temperature, and elimination of dust and carbon dioxide, both of which are very injurious.

TENNESSEE COPPER CO.

The construction of their acid plant was begun in the early part of 1906, and was completed late in 1907. Acid making was commenced about Dec. 1, and the plant has been in nearly continuous operation since that time.

The gases in this plant are drawn from a concrete flue back of the plant furnaces. The first unit of the plant was completed in 1907, and a second unit added later and completed in 1910. The plant at present comprises two octagonal Glover towers 30 ft. across and 50 ft. high; one flue from the Glover tower to the cooling chambers, which is 10 ft. by 20 ft. by 120 ft.; 64 cooling chambers 10 ft. 10 in. by 10 ft. 10 in. by 70 ft. high; 8 cooling chambers 10 ft. 10 in. by 24 ft. by 70 ft. high; 4 lead-lined fans, each with a capacity of 67,000 cu. ft. of gas per minute; 12 old chambers 50 ft. by 50 ft. by 70 ft. high; 6 new chambers 50 ft. by 50 ft. by 75 ft. high; 8 new chambers 23 ft. by 50 ft. by 80 ft. high; 4 old Gay-Lussac towers 23 ft. by 23 ft. and 50 ft. high; 4 new octagonal Gay-Lussac towers, 19 ft. across and 70 ft. high. This, with the necessary coolers, pumping apparatus, and 15 iron storage tanks with a total capacity of 15,000 tons of acid, make this the largest single sulphuric acid plant in the world. To this equipment there is being added two new octagonal Gay-Lussac towers, 19 ft. across and 70 ft. high, upon which work was started in 1910.

To give some idea of the size of the plant the following figures are given, showing the amount of materials used:

The foundations called for 84,400 cu. yds. of dirt to be removed; 50,000 sq. ft. of asphaltum was put in for flooring under the chambers; 1,346,000 chemical brick; 270,000 fire brick and 2,210,000 red brick were used in flues and connections; 7,335 tons of quartz in packing the towers; 550,000 lbs. of asbestos in insulating the flues, and 7,830,000 lbs. of lead for chambers and towers, etc.

On Dec. 31, 1910, the acid plant construction had cost $1,689,925, and at that time the annual capacity was estimated at 168,000 tons of 60 degree acid yearly, or a cost for the plant of $10 per ton of annual capacity. Figuring on a 10-year depreciation period, amortization and interest charges the cost to the Tennessee Copper Co. will be about $1.60 per ton of acid.

DUCKTOWN SULPHUR, COPPER AND IRON CO.

Ground was broken for this acid plant on July 14, 1908, and on June 11, 1909, the fans of the completed works were started. For the first 24 hours a yield equivalent to 83 tons of 60 degree B. acid was recorded.

The plant consists of two Glover towers 12 ft. square and 45 ft. high, a series of dust chambers, four leaden fans of special design, 16 leaden chambers 96 ft. long by 22 ft. 8 in. wide and 30 ft. high, with a total volume of 1,050,000 cu. ft.; six Gay-Lussac towers, and the necessary equipment of storage tanks, pumps, etc.

In operating this plant the gases from the furnaces go into the furnace dust chamber. From this dust chamber the gases pass into and rise through a cylindrical tower, then through a kite-shaped flue into the special dust catcher, which is a rectangular brick chamber containing a system of channel iron. These are held in place by a series of trunnions running along the side of the walls. On one side the trunnions extend through the side wall, the ends being squared, by which means the channel irons can be revolved by a wrench and the contents dumped on the floor, and then be withdrawn through suitable openings underneath. These channel irons are to catch the impalpable sulphates and dioxides, which settle very slowly at high temperatures.

This dust chamber is very important, as it is through the manipulation of its connecting and extension flues that the temperature of the gases is controlled and regulated. From the dust catcher a brick flue runs the entire length of the building, with separate take-offs for each Glover tower. In each of these take offs are placed nitre boxes. Also there is another set of nitre boxes at the end of the dust catcher to be used if the occasion arises.

The next point in the process, where there is any change from the ordinary chamber acid process, is in the leaden chambers, where the contaminating influence of the carbon dioxide is felt. Here special features of a proprietary nature have been introduced, which are said to entirely eliminate the injurious effects of this gas.

In the Gay-Lussac, as in the Glover towers, no changes have been made from the regulation type, except in size.

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The earliest use of asbestos was for spinning and weaving, to make incombustible thread and yarn rope and cloth, and this has continued to be the most important use of asbestos ever since the days of the Greeks and Romans. Only the best grades can be used for this purpose, according to J. S. Diller, of the United States Geological Survey. Thread can now be spun so fine that it will run about 32,000 feet to the pound.

SQUARE-SET MINING AT THE VULCAN MINES

By FLOYD L. BURR.*

Since the invention of the square-set system of timbering by Phillip Deidesheimer in 1860, at the Ophir mine of the Comstock lode in Nevada, it has been used under widely varying conditions in many districts and may be considered to possess in a very marked degree the qualities of safety, thoroughness and general conservatism; while it is always open to criticism on the score of expense. Being used under such varying conditions and by men with widely varying ideas, it is not surprising to find very considerable differences in the dimensions of the timber, the detail of the joints and the general application of the system.

This square-set timbering was developed to take the place of simple props when the Ohpir mine vein suddenly widened out with depth from 4 ft. to about 70 ft. It was of course, entirely impracticable to span such a width between the hanging and foot walls with a one-piece prop or stull timber and in order to produce what would be in effect a prop made up of several pieces, the square-set scheme was devised. The idea was that the compressive stress due to the weight of the hanging wall would be resisted by a series of "caps" butting against each other and held in alignment by other members acting at the joints. This conception of the function of the caps makes them the principal members, the others being more of the nature of auxiliaries. Probably this condition is most nearly true in case of steep dips. However, in the use of the system in general, there are places where the "legs" or the "dividers" may have to carry the heaviest load and indeed they must always carry certain considerable components of the main loads. It must also be borne in mind that the timber is used incidentally as staging from which to carry on the work of mining and to support temporarily considerable amounts of broken ore. These incidental functions of the timbers may indeed have a strong bearing on their manner of use and in the selection of sizes.

There are many systems of details for framing the ends of the pieces to form the joints, depending on the conditions of pressure, cost, facilities for framing, etc., as these conditions appear to the man who directs the mining operations; but it is my belief that timbering is carried out too generally by a blind following of the local time-honored method with little consideration of the actual requirements. To design a joint scientifically one must first decide as to the magnitude and direction of the pressure and stress to be resisted and then dispose the timber in such a way as to best serve the purpose, it being of paramount importance to remember that timber is about five times as strong to resist compression along the grain as it is across the grain.

This square-set system of timbering has made possible and given rise to a number of square-set systems of mining. That in use by the Penn Iron Mining Co. at its Vulcan mines might be called the "square set room and-pillar" system of mining. There are several other mining methods in use at these mines, the most notable of them being the "top-slicing" system, which is sometimes used independently, but more often as an auxiliary to the square set work to mine out the ore pillars left between the square-setted rooms. In the mining of soft or medium ores, the square-set room and pillar method is applicable where the ore body is too wide for stull timbers; where it is so irregular in shape that in following out the limits of the ore the width is liable to vary greatly and unexpectedly; where the condition of the rock back is such that it will not cave down successfully for the top slicing method; where caving methods in general cannot be used for fear of destroying valuable or essential surface works; where previous operations have rendered underground conditions unfit for caving methods; where it is necessary to begin mining on several levels at once instead of progressing only from the top downward; where the output must be forced in quantity or in date; where it is considered essential to recover with certainty all the ore; and in general where conservatism is the ruling factor.

Fig. 1. Plan Showing Development Drift and Outline of Rooms and Pillars.

Due to the existence of some of the above conditions at Vulcan, the system has been quite generally used there. Levels are usually established at 100-ft. intervals and when the ore body is encountered the drift is continued throughout the length of the ore, there being no regular practice as to following the foot or hanging walls or drifting in the middle. Some crosscutting is done at irregular intervals, thus defining the general limits of the ore body. Frequently raises are driven upward to connect with the level above for ventilation and for lowering timber.

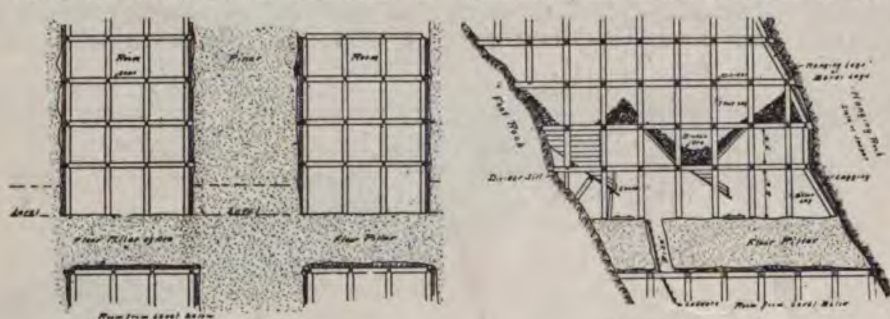
Fig. 2. Plan Showing the Irregular Size and Form of Orebodies Often Met With at Vulcan.

In beginning the mining operation a line for the timbering is chosen, sometimes paralleling the timberwork on the level above and sometimes being a line parallel to the longitudinal axis of the ore body as nearly as may be approximated from the development done. When there are pillars of ore still unmined on the level above, it is of course considered essential to keep that in mind in the laying out of rooms and pillars, which comes next in sequence. At right angles

* Paper read at Marquette Range Meeting of Lake Superior Mining Institute.

to this longitudinal line which has been chosen for the timbering, rooms are laid out. These rooms are made from two to four sets, or from 14 ft. 10 in. to 29 ft. 8 in. wide and their length is of course the width of the ore body. The intervening pillars vary in width from two sets to five sets.

Fig. 1 shows the plan of a certain level in one of these mines being worked by the square-set system. This ore body is larger and more regular than many of



Longitudinal Section. Cross Section.
Fig. 3. Showing Square-Set Timbering and Scheme of Mining.

them, but the smaller and irregular ones are worked the same way. In this figure an irregular development drift has marked out the limits of the ore in a general way and then rooms have been laid out, leaving pillars between them. The heavy dotted lines are the side lines of the rooms. The area occupied by pillars is shaded. Fig. 2 shows the irregularity in size and shape commonly met with in the Vulcan ore bodies.

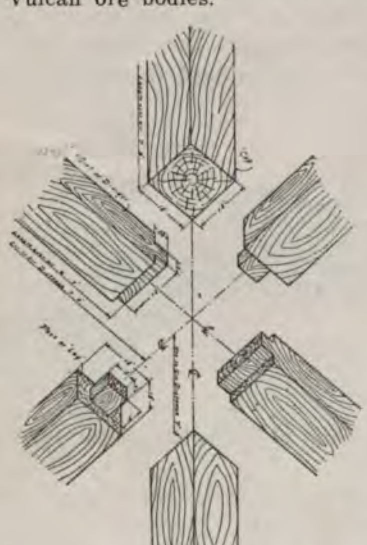


Fig. 4. Dimensions and Detail of Square Set Joint.

As the rooms are gradually cut out on the level, square sets of timber are placed in position and usually a set is placed as soon as there is space for it, thus avoiding large areas of unsupported back. The sets are blocked in place and 7-ft. lagging are laid on top. Usually 9 ft. legs are used for the first floor, while all other floors have 7-ft. legs. These lower legs are usually stood directly on the ore beneath, it not being found necessary to use sills to distribute pressure or to tie the legs together. Years ago sills were used regularly. The only reason for using sills would be to facilitate the "catching up" of the debris when the room has been filled with waste rock and the workings below have progressed up to the level. Instead of using sills, the present practice is to anticipate the beginning of the filling operation by laying down on the floor of ore at the level a sheeting of 10-ft. round lagging, it being comparatively easy to "catch up" this lagging when working up to it in the

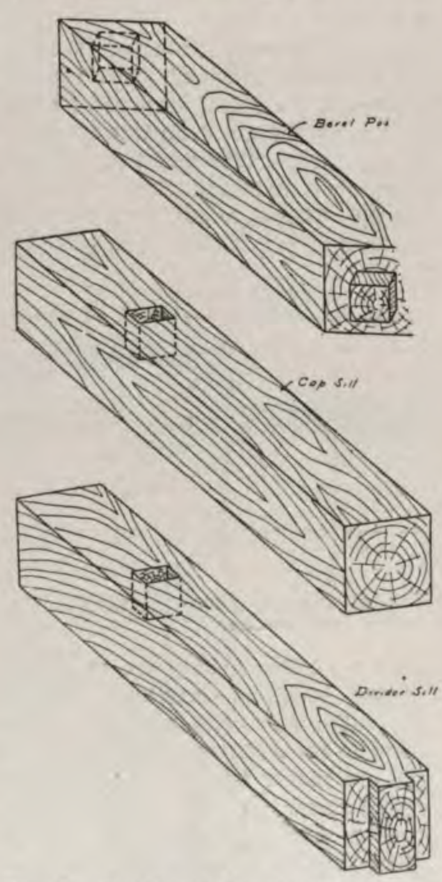


Fig. 5. Detail of Special Members of Square Set.

subsequent operations from below, and to thus avoid the caving down of loose filling material. The sides of the rooms next to the pillars are lagged up outside the legs of timber to prevent the ore from the pillar caving into the room.

After a given room has been cut out and timbered the ore set in height over the whole area from hanging to foot, thus completing the "first floor," the lagging are removed over one set and an opening is cut upward large enough to accommodate a set of timbers, thus beginning the "second floor." This floor and the succeeding floors of ore are in due time mined out one set at a time and the timbering left in its place until the level above is reached, or to a point some 15 ft. under the level in case it is necessary to leave a floor to accommodate haulage ways or other conditions on the level above. In the most usual case when a 15-ft. floor pillar is left, a raise is cut through it connecting to the level above (see Fig. 3).

In blasting down the ore it is allowed to accumulate to some extent on the various lagging floors and occasionally the "stope is cleaned up" by shifting the lagging like the dumpboards of gravel wagons, allowing the ore to fall down into the chutes which have been provided at the level. The various rooms in the series will generally be found in different stages, some being worked nearly up to the limit, while others are barely begun.

In the course of action, the rooms are filled up with waste rock produced elsewhere in the mines by the driving of exploratory drifts and other openings or sent down from surface rockpiles in cars or chutes; or in case these sources do not yield the necessary material, rock is mined for the purpose from suitable places in the hanging or foot walls. This rock is trammed in cars and dumped down from the level above until the room is full. Of course the timbers are left in place and no attempt is ever made to recover them. Before starting to fill a room, a sheeting of split lagging is placed at the side of the room bearing against the lags toward the pillar to prevent the subsequent rock filling from running out when the pillar is being worked later on.

I understand that some years ago at the West Vulcan mine the filling was "puddled in" with water and the result was a material like a water-bound macadam, concrete like in its ability to stand up as a rigid mass. This, I presume, would hardly have required the support of lagging.

Whatever passage ways it is desired to maintain are cored out in the rock filling. These may include a ladderway between levels, tramways on the lower level and suitable mills adjacent to the pillars. These mills are to be used for access to the pillar and for chutes down which the ore is sent when mining these pillars by the top-slicing method. When all the

rooms have been worked out and filled, the pillars are usually attacked by the well-known top-slicing method. By this method the ore is mined from the top of the pillar in a "slice" only some 10 ft. in depth and the debris above caved down as each successive slice is removed. At the same time the floor pillar left over the adjacent rooms may be removed.

While the method as outlined might be called the standard method, it is frequently departed from in several ways. Thus sometimes the pillars are worked away as extensions of the rooms by what is known locally as "side slicing." The side slicing has been used considerably. To explain it: Suppose we have a pillar three sets wide between two rooms each three sets wide. After the rooms have been worked out and the square-set timbering occupies the space, it may be found that no severe strain has shown its effects upon the timbering and the ore pillar shows no tendency to cave. Under these circumstances it may seem wise to risk taking off a slice one set wide from one side of the pillar. This then widens the adjacent room to four sets wide and reduces the pillar to two sets wide. This space is of course timbered with square-sets precisely like those in the rooms, progressing from set to set and floor to floor. After this one slice has been successfully cut off from our pillar, we may be bold enough to risk taking off a similar slice from the other side and finally removing the remaining third producing a great room nine sets wide; or it may be considered too risky to do this and resort be made to filling the rooms and top slicing the remaining portion of the pillar.

Sometimes the above described procedure is carried on with the variation that the rooms are filled in the usual manner with waste rock before attacking the sides of the pillars. Sometimes also after the rooms have been filled with waste rock, the pillars are "taken out on timber" as it is spoken of locally. In this scheme the pillar is treated just as if it were a room and the filled room a pillar, the whole three sets width of pillar being mined up and timbered with square-sets.

Taking up now the details of timbering, reference should be made to the sketches. In Fig. 4 the joint is shown in modified isometric projection. The sketch represents 12-in. timbers, but 10 in. and 16-in. timbers are also in use, the tenons on the legs being made 4 and 8 ins. square, respectively. It will be noticed that the framing is extremely simple. A great deal of the timber is framed by machinery, but there is also some hand framing. Both round and square timbers are used.

Fig. 5 shows a "divider sill" and a "cap sill" and a "beveled post," and their use is indicated in Fig. 3. The "divider sill" is used to allow the timbering to progress over the footwall, while the "cap sill" may come into use in a similar way at the end of the ore lens at the foot of the pitch. The "beveled post" or "hanging post" is used in following up the hanging wall.

Contrary to the more usual practice, the caps are placed along the strike of the vein and the dividers at right angles. I am informed that the reason for this is that it is desired to place the overhead lagging in the direction from foot to hanging and since it must take the weight of ore blasted down upon it, it must rest on the stronger members—the caps—the caps being the stronger because they have the greater bearing area on the leg.

The legs are spaced 7 ft. center to center from foot to hanging, while in the longitudinal direction they are at 7 ft. 5-in. intervals.

STATUS OF THE WORLD'S GOLD DREDGING INDUSTRY

By AL H. MARTIN.

In 1911 the gold deposits of the world yielded approximately $466,000,000. Of this immense amount about $20,000,000 was produced by dredging. California leads with $8,000,000; the Alaska-Yukon districts ranking second with nearly $3,500,000. New Zealand, the birthplace of the industry, yielded in excess of $1,500,000. Russia leads the Eastern regions with over $2,000,000. It is estimated that fully 390 dredges are in commission ranging from the native machines of the Philippines and the little Holland built boats in Dutch Guiana, to the 15-cubic foot monsters in California and Yukon. The dredging industry had its inception in New England in 1867, when the first placer mining bucket elevator dredge was constructed at Otago. The contrivance was a crude affair but the lessons learned resulted in the building of several successful machines. The boats were operated by current wheels, the first steam-operated dredge going into action on the Molyneux river in 1881. In 1889 a large number of gold-boats were operating in New Zealand, and the commercial value of the industry had been established. These boats were all small and generally cost less than $20,000 apiece.

The first successful California dredge was commissioned in 1898, twenty-one years after the first New Zealand machine was designed. The present status of the world's gold dredging industry dates largely from this pioneer California dredge, as California operators have solved the problem that heretofore reacted against the universal application of the dredge principle. As a result the California single-lift bucket elevator type of dredge is generally accepted as the world's standard. Practically all the dredges operating in Alaska, Yukon Territory and the various American States are modelled along lines decreed by California practice. Even in New Zealand the tendency is toward the adoption of the larger California type of boats, and dredges of this type are finding favor in Siberia, South America and other foreign climes.

Throughout the world the tide has set strongly in favor of the larger dredges, as the handling of a large quantity of material means a lower cost per cubic yard. In California a majority of the dredges are treating gravel at a total cost of 2 to 3 cents per cubic yard, and operators in other localities are endeavoring to aproach the California record. In Alaska and Russia the costs often run around 10 to 40 cents per cubic yard, owing to the necessity of employing steam or gasoline for power, the thawing of frozen ground, heavy freight rates and other expensive factors. In New Zealand and Victoria several companies are handling gravel with small dredges at costs averaging around 4 to 5 cents per cubic yard. The following table shows the approximate number of dredges in operation throughout the world, based upon recent reports from the various mining authorities of the several nations:

Location.	Dredges Working.	Production.
California	63	$ 8,200,000
Other Am. States	20	1,450,000
New Zealand	100	1,500,000
Australia	75	2,000,000
Alaska-Yukon	40	3,300,000
Russia-Siberia	60	2,200,000
Other Fields	32	1,500,000
Totals	390	$20,150,000

These are approximate figures, based on dredges reported in action at this time. The principal American dredging states exclusive of California are Colorado, Montana and Idaho. Colorado dredges produced about $350,000 in

1911; Montana produced $700,000, and Idaho dredges yielded about $210,000. South Dakota, Nevada, Oregon and Arizona have received some attention during the past year, with small dredges operating part time in Arizona, Nevada and South Dakota. Montana for years has ranked as an important dredging State, and antedated California as a producer with dredges.

The dredging fields of the far north are attracting particular attention at this time, and a marked advance is anticipated during the next few years. The greatest difficulty attending dredging in the extreme arctic sections of Alaska, Siberia and the Yukon is the thawing of ground sufficiently to facilitate its handling. In this work it is necessary to drive pointed iron pipes into the ground through which steam is introduced. The steam is supplied by boilers generally fired by wood or crude oil. From twelve to twenty points are frequently required to thaw the frozen ground as the dredge advances, and this alone costs considerable, 10c. per cubic yard being a very favorable figure. Average dredging costs in many of these districts run about 22c. per cubic yard, with conditions considered propitious. This indicates the extreme difficulties under which dredging companies in the Far North labor. Consequently only ground of remarkable richness can be profitably handled, and this factor will continue to militate against dredging in numerous northern sections. In more temperate portions of Alaska and the Yukon companies are effectively operating at a total cost of 10c. per cubic yard. During 1911 eighteen dredges were operated on Seward peninsula, most of them during the greater portion of the summer. Five more will shortly go into commission, while more are projected. During the colder weather many of these boats operate by keeping the various portions of the dredge heated by an arrangement of steam pipes.

In South America dredging with small machines has progressed for years in Brazil, Argentina, Colombia, Dutch Guiana, French Guiana and other nations. Most of these boats are small and constructed along lines developed by native practice. While the aggregate volume of gold yielded by South American dredges is comparatively small, numerous rich placers offer much promise. Climatic conditions are often unfavorable, and it has been found expedient to build boats with steel hulls to resist the attack of voracious wood-devouring insects. Frequent floods also add to the uncertainties attending operations.

In Russia the dredging fields of Siberia gather importance as the efficiency of the practice increases, and strong foreign interests become more heavily concerned. The small Russian boats are admittedly inferior to American and New Zealand designs, but the natural timidity of Russian capitalists militates against broad advances in dredge construction. Prominent engineers pronounce conditions distinctly favorable for the development of a great dredging industry in the Siberia district, but it is apparent that introduction of boats built along the lines developed by California and Alaska practice will be deferred until outside financial interests become more largely concerned.

A powerful French corporation recently installed an Australian model dredge near Lake Baikal and is said to be planning the erection of a number of similar boats. English capitalists are manifesting renewed interest in Siberian dredging. A majority of the Russian dredges have capacities ranging from 4½ to 5 cubic feet, but most of the newer type are provided with 7 cubic foot buckets. According to official statements some of the ground in the Urals may be profitably worked when the gold content runs as low as 10 to 15 cents per cubic yard, while in portions of Siberia deposits containing less than 20 to 32 cents per cubic yard are unprofitable, owing to unfavorable conditions.

Other regions reporting dredging activities are Terra Del Fuego, in the extreme southern portion of South America, the Malay Peninsula, the Gold Coast Colony and French Guiana, in West Africa. As a whole the introduction of dredging into remote districts has been attended with fair success, when conditions were properly appreciated and dredges were designed for the particular locality selected.

The outlook favors a pronounced expansion of dredging in Alaska, Yukon, Russia and South America, while California and several other American States will probably record a steady gain in production for several years to come. In Mexico and Central America conditions are reported favorable for a more extensive application of dredging principles. New Zealand and Australia show little promise of further gains, but should maintain present rate of production for a considerable period.

HYDROGEN-SULPHID APPARATUS

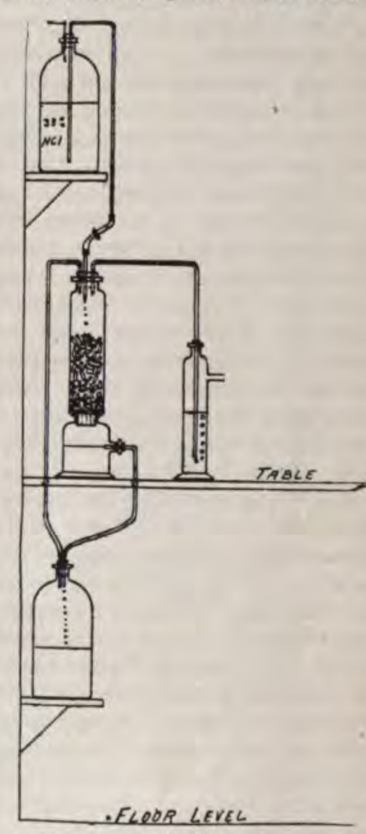
By J. R. HUBER.*

The accompanying sketch illustrates a convenient and satisfactory method for making H_2S in the laboratory. A Kipp generator, owing to the pressure necessary to hold up the acid when not in use, has a tendency to leak around the stoppers and consequently generates most of the time, being a continual source of annoyance besides wasting acid and iron sulphide.

Hydrochloric acid, about 1 to 2, is placed in the upper bottle, the syphon filled and the flow of acid adjusted by means of a screw pinch cock. When no more gas is required the pinch cock is screwed up tight. The generation of gas ceases almost immediately.

By using an 18-in. tower the acid trickles over sufficient FeS to be entirely neutralized when it flows out at the bottom. A large cork with several small holes punched through it serves to hold up the FeS and permits the waste acid to flow into the reservoir below.

Two holes are drilled through the table top, one for the tube which carries away the waste acids and the other for a tube connecting the waste acid bottle



Hydrogen-Sulphide Generator.

with the top of the tower. This tube relieves the pressure in the waste acid bottle, permitting it to be tightly corked, thus preventing any odor of the gas from getting out into the room. The other bottle contains pure water for washing the gas, and after it may be placed whatever purifying or drying apparatus is considered necessary for the work in hand.

FeS in fused sticks is the most convenient form to use. The apparatus is best set up in the hood against one of the walls.

* Metallurgical and Chemical Engineering, December, 1911.

PRINCIPLES AND PROBLEMS OF MINE MANAGEMENT

By CHARLES A. CHASE.*

This paper deals with the relations between the mining community and its principal industry, as well as with the duties of the manager. We all know that the key to successful mine management is a bonanza and yet with that knowledge it seems that we have to search deeper for the root of some of our troubles. This subject looks large, embracing finance, organization and operation, each with its several branches.

The object of the movement, of which this paper is an expression, is to look frankly at our industry and see whether we can discover its fundamental weaknesses and correct them. Business in general lags and, even so, the financial end of this industry does not keep step. By this expression, "the financial end," I mean our external financial relation with the great body of business, the source of capital for development and equipment, as distinguished from our internal economics. I assume that our chief trouble is internal, concerned with organization and technique, and shall devote myself to the phases of management connected therewith, for it seems obvious that the weakness internally has much to do with the distrust which results in withholding capital. I wish, however, to expressly disassociate my discussion from the narrow idea of the duties connected with the position of manager.

Mine management begins with location and we are all involved therein, be we locator, surveyor, superintendent, manager, director, owner or citizen in the mining community. The end is profit to ourselves as individuals, to the industry and to the state. Definite duties fall properly upon the regularly appointed manager, but it is imperative that all the classes enumerated, particularly the business and professional men of our mining communities, understand the burdens they must assume, if the industry is to thrive. Perhaps I may distinguish between the management of mines and the management of the industry, and state that, in the first case, the major burden is with the property manager and in the second case it is largely shared with the local business community. To the broader view of the subject I will address myself largely.

PROBLEM OF THE SMALL MINE.

I wish to deal with broad principles of general application. In a state where most of the individual mining enterprises employ less than 25 men and the individual output is correspondingly small, it is idle to discuss management as it is discussed at Johannesburg, Butte or Bingham. At such places the mines have grown so strong that they are largely independent of the co-operation of their several communities and a discussion of management there is of the technical features of organization, equipment or metallurgy; and, I may say, theirs seems a simpler subject matter than ours.

They have a problem which makes a steady evolution, each year's work, carefully analyzed and compiled, making a secure foundation for the years to come. To us the production of a tithe of the tonnage means the operation of many more properties, each with technical problems as difficult, but without the complete records and the equally available financial resources to supplement our natural resources. We have more problems per ton. The total difficulties are greater and the individual reward is less. On the other hand, the community of small mines offers more positions of responsibility and therein lies one of its rewards.

It is not for us to put aside the work of the large mine as having no lesson for us, for we can with great profit study its directness of attack, rigid avoidance of waste and careful adaptation of means to ends.

The successful mining community is our watchword. Some prospects grow into small mines and cannot become more; others have to be operated on a large scale to be at all successful. The successful nourishment of growth in the early stages calls for the highest skill and the broadest experience. It is appropriate to paraphrase a truism into these words: Take care of the prospects and small mines and the large mines will care for themselves.

HINDRANCES TO MINING DEVELOPMENT.

There are some difficulties which I wish to point out, certain remedies which I wish to suggest, believing that they are worthy of your consideration: First and, unfortunately, not subject to fundamental correction is the mining law, which permits the granting of patent to mineral lands, resulting in tying up in idleness large areas of every proved district in the West. This land is largely held, by virtue of low taxes, waiting for the day when someone, despite high royalties, makes a fortunate strike and gives it a value all unearned by the owner. We can look with some respect at the Mexican law, which rates mining as a public utility and does not grant title in fee simple to mineral deposits. We hear much of the leasing of coal and other government lands; I believe that the leasing of mineral lands would quicken the industry.

Second, inherent in the industry is the geological fact that not all prospects and mines can make good.

Third, is the bad judgment on the part of the prospector and the small owner in exhausting his own resources and those of his friends (which means in the aggregate the resources of the community in money and credit) in development of worthless prospects or of good prospects in a bad way. His faith may be good, but he does not know. This, too, is inherent in the industry.

EFFECT OF INEXPERIENCED OWNERS.

In some industries there is an orderly development of skill through the succeeding stages of apprentice, journeyman, superintendent, manager and owner, the latter a master workman in his industry, with all details of operation, accounting and organization practically a part of himself. Our industry does not ordinarily offer a parallel; in its nature it cannot, when a man of any vocation becomes an owner, but not a master workman, by the mere act of location. Our only approximate approach to an orderly evolution is in the case of the technical graduate, who goes faithfully through the various stages of apprenticeship by some one of various routes and finally becomes a master, be he manager, owner or engineer. There are notable exceptions, great miners who are notable executives without education in the schools, but I am dealing with the average man.

Fourth, and of a parcel with the preceding point. The owner of a prospect or small mine magnifies what he has and persuades an outsider to buy an in-

*Mining engineer, Denever Colorado. Address delivered at Idaho Springs, Colorado, as one of a series of "Practical Talks" given at various mining centers under the auspices of the Colorado Scientific Society during the past fall and winter.

terest or all on too severe terms. The buyer, his ignorance already shown by the terms of the purchase and likely without adequate capital, collapses before he can do sufficient development and construction.

Fifth, the preceding dangers to the property passed and a mine fairly started, it fails for lack of proper organization and lack of technical skill. There is sometimes dishonesty, a final straw.

SUGGESTED REMEDIES.

To suggest what relief I can: I see no prospect that our fundamental law will be changed but I do see that a growth of public sentiment favoring reasonable terms of lease would be of great value. This would best be accomplished by the intervention of the local commercial bodies, which would work out standard systems of leasing adapted to the district or to sections of it, and secure the concurrence of owners of idle property. The terms might be such as would even be comparable with government leasing. I do not contemplate such leasing as will gut property, but terms that will favor development, with little or no royalty on ore recovered in development that is properly planned. This seems to me to be a legitimate and highly desirable community activity.

For the waste in developing hopeless prospects or good prospects in a bad or needlessly expensive way, there is just one help, and that is to secure good advice from a competent man. I mean hopeless prospects when I say it and have in mind those in areas reasonably proved to be hopeless, those in vein systems amply proved to be barren and such as are cut off by faults or in landslide blocks. These will serve as examples of this class, a small class at best, as compared with the fair or good prospects developed on a bad scheme or without any plan at all. For the waste in developing reasonable prospects that do not make good, I see no help with our knowledge in its present state. It seems a proper and necessary part of our work, and, if the work is well planned and skillfully executed, the industry should profit in the long run.

The practice of making sales at too high a price or on too severe terms brings its own retribution to a district, in stagnation, and in monuments in the shape of ill adapted or uncompleted plants. The terms of option and sale are essentially matters of private contract, but where unfair terms and misrepresentation bring discredit upon a district, an enlightened public sentiment may demand that it be heard and may demand good faith and fair terms. This is not chimerical, for I know of a case where a large enterprise is just now being resuscitated after years of idleness, where a good community spirit forced reasonable terms.

This community spirit may fairly show itself in pointing out to intending purchasers that they should safeguard themselves with the best engineering and geological advice, that if they are to take a partially developed property, their only safe plan is to follow a program of development mapped by competent authority and it can well aid in securing the time for the necessary development and equipment, before payments are scheduled to begin.

SALE OF MINING PROPERTIES.

There are two classes of property, at least, to which much of what I have said in this connection does not apply. A bonanza prospect is a law to itself, and a developed mine is subject to sale for cash with fairness to all parties immediately concerned and to the public.

Why the severe terms for prospects of small apparent value and for ill developed mines? The seller lacks faith in the property he is selling or in the ability of the buyer to make a success of the enterprise that he is undertaking. He takes the cash payment as insurance to himself against the poor results of development on the one hand and against the possible failure in management by the new owner on the other. It is not good practice, for this first sum should go into development, which often brings its pleasant surprises as well as its disappointments; and it is ample development that makes mines.

This is something that I believe to be reasonable: If in any mining district there is an orebody that bears the marks of good size and its grade is at or just below what can be worked with the equipment now at hand in the district, it may be recommended to outsiders for development or it may be developed by local people as an investment, with the reasonable assurance that, by the time a large tonnage is ready the means to treat it at a profit will be available. As a case in point in showing the steady progress in metallurgy, I understand that now, for the first time, cyanidation has been made adaptable to certain ores of this district. I say "made adaptable" advisedly, for that is the essence of engineering. I hope that it may prove a success and that you may have the courage and good fortune to develop orebodies of such size as to make the most of this branch of metallurgy. The men who have accomplished this result deserve the appreciation of their fellows.

Let the owner and community offer time for development and demand that development be done; it is at once a safeguard to the buyer and a sure test of his intentions and abilities. I believe that any district of real merit in which the people avowedly stood for this good practice would attract a good class of investors.

ORGANIZATION IS ESSENTIAL.

The failure of the developed mine for lack of organization and technical skill is common and sad. At a time when business in general, your smallest grocer if you please, with his cash register and other appliances, is trying to make light the dark places, our industry remains in general archaic. I know a man of more than average intelligence, who runs a mine with the aid of a pocket memorandum and check book, as far as I can see. When the ore falls in grade, he will either change his methods or break; unfortunately he is not alone in this method.

The necessity of right organization is common to all mines and is merely the application of business principles. To properly organize is to provide the mechanism, the staff of men for supervision and the system of accounting and communication to make their work effective. The aversion to accounting in general among mine operating men results from the inapt and cumbrous nature of some systems in use and inappreciation of the benefits to be had from a good system, fitted to the needs of the individual mine. When a foreman explains that there is a great deal of red tape on the mine, it is a fair inference that the system is wrong or, if right, that man has not been taught to use it. Certainly, properly adapted accounting simplifies the work for manager, superintendent and foreman. There must be many figures, but the working out of the details of the accounting is to be concentrated in the hands of the clerk, where it belongs.

SYSTEM USED AT LIBERTY BELL.

To the student of ways and means, citations from actual experience are of more value than theoretical conclusions and I will now cite to you a particular mine and outline its organization and methods, as a good example. The mine is the Liberty Bell and, the system in use having antedated my presence there, I can speak of it from the standpoint of user and observer. These principles underlie the scheme: the provision of adequate executive supervision; the definite placing of responsibility; the definite knowledge of every expenditure; the definite knowledge of mill results; and the requirement that everyone is in a position of responsibility to tell in the simplest way just what he has done. The staff organization is thus: (1- General

manager and president (nonresident); (2) superintendent (resident); (3) chief clerk and cashier, with necessary subordinate clerks and boarding-house steward; engineer, with assistants as required by the work; mine foreman, with shift bosses and mine mechanics; tram foreman, with shift bosses; mill foreman, with one general assistant and shift bosses.

Each department head has well defined duties and a large measure of independence. In the system of reports and accounts is his bond with the superintendent and the latter's best means to gage the work of the foreman. In the figures that come back to the foreman is his opportunity to know his own results. Any good foreman knows in some measure how his work progresses.

He cannot know this exactly without figures and this requires bookkeeping; if he does it himself, it will be at the expense of his essential work.

RECORDS OF THE FOREMAN.

To illustrate the foreman's relation to the general system in telling what he does and what he requires in the way of supplies, I will take the mine foreman, who turns in the following sheets daily: (1) Mine-labor report, which shows on its face how many men of every class were employed, surface and underground. (2) Mine-ore report, which gives the ore and waste produced and, what is to the point, if the tonnage of ore is below standard, the reason must be given there. (3) The daily log, a letter sheet which must go forward every day, blank or filled; if blank the foreman assumes the responsibility of reporting good conditions. Otherwise the opportunity is at hand to call attention of the superintendent to any condition of the work; and, what is more important to the foreman, it offers him scope for his own ideas; it permits him to make recommendations. This report definitely places the burden of responsibility between foreman and superintendent. (4) Requisition blanks, numbered, form the simple means of asking supplies. Beside the statement of the want, the essential addition is the purpose. The foreman has at hand the list of headings, to which it is customary to charge mine supplies and labor; foreman and shift boss; stoping; underground hauling; tunnel raise; blacksmithing; tracklaying and ditching; heating; lighting; telephones; air plant; electric plant; electric power; locomotives; cars; miscellaneous.

This short list the foreman knows and to the various headings he charges all labor and supplies. It is needless to say that the foreman retains copies of all reports and requisitions. These simple duties performed, he has fulfilled his part in initiating proper records. It is not complicated and cannot be a burden; in fact, the ordering of supplies is almost machine like at the end of each month. In return the superintendent supplies the foreman with the account complete at the end of the month, totals and summaries of all classes of labor and supplies and the cost per ton.

REPORTS OF DEPARTMENT HEADS.

What the mine foreman does is typical of the duties of all foremen; and all reports go to the superintendent. In 15 minutes he will have entered the essential items of every report across his summary sheet. The entries on this sheet are, for the mine: tonnage, total labor, total underground labor, machine shifts; for the tramway, tonnage; for the mill: tonnage, total labor, amalgam product, concentrate product, tons cyanide solution and its value and other current assays. At a glance he can see whether any item shows change from the day, week or month previous.

The sheet is an index, par excellence. In the case of lowered tonnage in any department, the detail sheet gives the reason and so in the case of high labor or any other irregularity. The recurrence of trouble in any quarter suggests that any remedy theretofore applied has not proved adequate. In a word, the signals are automatic, and there is the crux, the simplicity of the system. Foreman, superintendent and manager, all see the daily reports and superintendent and manager see the summaries, and, for all, the clear sheets, with full tonnage and normal labor, show the perfect working machine and allow freedom to study some particular part of the work and to improve practice.

The word distribution is used to designate the name of the account to which the foreman on his requisition signifies that the cost of the item he orders is to go. This is never lost sight of. The order to the supply house, written in triplicate, has the notation on the office copies and, when the bill is received with the goods, it is entered thereon. At the end of the month, there remain only the totaling of the various distributions and the entry in the books. The reports of the various departments are then compiled and analyzed.

STORE AND CONSTRUCTION ACCOUNTS.

The essential remaining features of the accounting may be discussed together. Ideal simplicity would accrue, if each item of labor or material could be given at once its proper and final distribution. This is not feasible, if one is to have the uniformity essential to comparison of results for different periods. The disturbing features are the purchase of some supplies in large quantities and the purchase and erection of machinery, buildings, etc., the former being distributed as used from month to month with exactness, and the latter approximately apportioned as depreciation through the assumed life of the mine. These equalizations are cared for by the "store" and "construction" accounts, respectively. Any purchase of supplies for use through an extended period, or for general use, is charged to the store when bought and then charged to the various departments at actual cost as used. All items going into any permanent construction are charged to their proper construction account, but after the construction is once complete, any further purchases are for repairs or maintenance and are charged off at once as operating expense.

I have given the salient features of a system that has proved of the greatest assistance in working out a difficult enterprise. My object in reviewing it is to drive home the fact that, as it touches the operating man, it is simplicity itself. It eliminates correspondence and conversation, the telephone being left for emergency use. It suits the needs of the staff men of all ranks. It is fundamentally the sort of system that the small mine can adapt with great profit.

This is not a meeting of accountants, but I propose to urge upon our organization the need of propaganda furnishing systems of mine accounting. The one fundamental principle should govern—the greatest accuracy compatible with simplicity and commensurate with the requirements of enterprises in various stages. Such work can be made invaluable.

EFFICIENCY BY CONTINUITY.

I have said that some mines fail for lack of technical skill. The mine I have mentioned was found in the prospect stage by an engineer, who later organized it for operation and has always directed its policies. The resulting continuity in plan and the constant accumulation of a fund of special knowledge have made the difference between success and failure. In the nature of things, not all mines can have this history, but the owners can secure good technical direction from men schooled by years of successful practice.

This may seem an unasked advertisement of the consulting engineer, but it is a statement of a logical course of action and it is the substance of what I have to say. A board of directors or a nontechnical manager, with faith in the engineer, secures the necessary continuity of policy and the accumulation and analyses of special knowledge.

There is no better illustration of the reasonableness of this advice than to draw a parallel with the professions of law and medicine. Men of these professions are essential to the everyday life and this is so because they are recognized as trained men. There are lawyers and doctors whom you do not trust and there are engineers who are not to be trusted. On the other hand, you of this vicinity do not have to think long to recall engineers of continent-wide practice won by sheer force of merit. The engineering schools turn out their annual crop of young men who, with good field training, will become competent. Not all will be great, but the mere fact of their training in the fundamentals will save them and their employers from the commonest mistakes which are so costly. That these graduates do not progress faster is due to the fact that they do not come oftener under the direction of trained superiors in their early years out of school.

RESIDENT AND NOMAD ENGINEERS.

T. A. Rickard some years ago entered a plea for the usefulness of the resident engineer, as against the nomad, as a source of consulting advice within a district, a man who will do intensive cultivation, if you please. For the good of the profession and the industry, there must be nomads, to carry good ideas and to keep the profession broad, where men too much in one place would become narrow. But this requirement becomes less with the increasing dissemination of good technical literature. The idea fits well with some of my own. I have felt that many graduates, who go in for assaying and surveying in our various communities, develop those lines into fine arts, but often shut themselves off from the larger opportunities and responsibilities, with detriment to themselves and the community. Is it not natural that the locator, who employs a surveyor to stake the claim properly, should ask his advice on the larger questions; whether the claim is hopeless; whether he sees any encouraging marks and whether he can suggest the most economical way to prospect it? So, with the owner or manager of property in more advanced stages, needing advice as to organization, operating methods or metallurgy.

To return to the analogy of the other professions; do you know a good local lawyer who does not consult a leader in his profession? The local engineer would have similar connections and would use them. A growing business with the confidence of the community, would mean the gradual growth of an engineering staff and therewith the steady accretion of compilations of engineering data and the mining and metallurgical history of the small mines of the district that is now had only by the larger and well managed mines, a tangible asset to the community and the industry.

The expense of engineering advice is as essential as powder, and more so, for it can give direction to the powder, with resulting enormous savings. Such a system is for the future, but we can gradually change to right lines. New conditions require new methods. The industry has had a chaotic history, in which the wealth of bonanzas has made skill superfluous. In parallel with the exhaustion of our richest deposits, has come the growth of our schools and scientific organizations and their product in men and ideas is the machinery for giving value to lower-grade ores.

There are certain phases of good management of operating mines that I wish to mention. There has been so much said of scientific management and some of the alleged examples are so bad that the expression is almost a byword in places.

EFFICIENCY BY MOTION STUDY.

Yet the principles enunciated are the thoughtful consideration of every mine manager. Conditions vary so widely that it is quite impossible to make any fixed rules for the application of these principles, but each manager must analyze for himself every operation in mine, tramway and mill.

In the operation of the mechanical plant, the results, whether favorable or adverse, are evident and serve as a gage of the management. The equipment and its operation may both be archaic, it may represent the latest approved practice or it may be almost original. Whatever it is in this way, it may be in perfect order or slovenly; each condition reflects its own type of management. Very commonly the mine that hoists by cage and cars represents the archaic type of mind and where this method is in vogue, the entire organization will probably be on a par. That any manager today will use such a method for a large orebody is incomprehensible in view of the well known examples of better practice. Copper Queen methods of moving ore are in point. The train goes by the station and discharges without stopping. In turn, by the use of measuring chutes or fillers, filled from the pocket while the skip is running, the skip loading is almost instantaneous. What a contrast the two types represent, and what excuse can be offered for the continuance in use of what should be obsolete? The ability to halve the time of a cycle in hoisting means that one shift will do instead of two, or one shaft instead of two. The labor ratio between the two methods is likely to be 4:1.

I may cite an instance from my own experience. It was reported that the maximum output of a certain level was 160 tons daily with one locomotive. A reorganization of the tramming crew, adjustments of track with introduction of automatic switches and a few changes in method brought the product of this level to 500 tons for the same one locomotive. The secondary but more important result was that it immediately became possible to concentrate the mining of that tonnage on the one stope; the one level above was the route for all timber and permitted the use of a single power-driven saw. All supervision had its maximum efficiency. This result was no more than natural, following a right analysis of conditions existing with knowledge of the requirements.

MANAGER SHOULD BE ANALYTICAL AND CONSTRUCTIVE.

One type of mind starts with what has been done in the past as a basis for the future and reaches the future result by mere process of addition and multiplication; it assumes that a man who has mined, trammed, timbered and bossed is therefore competent as foreman and superintendent.

The other idea is that, together with a good working knowledge of the details of the work, there must be the capacity to interpret, the analytical mind; and the power to remedy defects found, the constructive mine. It has seemed to me that some of our schools pay too much attention to the petty details of operation, things ephemeral and likely to be obsolete in comparatively little time, and too little time to the purely scientific and fundamental, which will force students to depths sufficient to develop the best that is in them.

There is danger in what is too new, for pioneering is costly. But for almost all mines tried methods, recently developed, perhaps, but accepted and proved, are available. Therefore the use of the untried is seldom warranted. When it is a last resort, skilled direction is particularly necessary. I have assumed that the operator should know and would know the latest accepted methods. I mean just this, for I believe that any manager or superintendent who does not give time each year to visiting other mines will probably become incompetent by reason of his coating of rust. It is essential and he does not need to confine himself to gold or copper or lead mines. Let him visit the coal mines and see to what extent their movements are automatic, automatic because they can not afford to trifle with the handling of coal. Of

course, he may be a loyal quartz miner and merely feel glad that he does not have to handle anything that must be moved so cheaply.

LESSONS FROM OTHER MINES.

We have had the grace to copy the coal miner's washery and picking belt with gratifying results. Henry M. Adkinson tells of dump washing and sorting by which material worth $3.73 was converted into $8.36 mill heads at a cost of 21c., and discarding 55 per cent of the tonnage taken from the dump. He goes further and shows that he was able to alter mine-stoping methods at a saving of 50 per cent. in the cost, while the cost of sorting out the somewhat increased tonnage of waste mined with the ore was but a few cents. The net result was excellent. This is an admirable case of nice adaptation of the means to the end.

Concentration of effort is always profitable and in mining it may be made so in driving one heading at high speed instead of two at half that speed. Supervision is easier and the result in doubling the amount of ore available at one time and one place is of great importance. The idea of consolidation of adjoining properties of the same character follows as a corollary. To cite further instances is to reiterate, though there are many examples of extraordinary results from the application of great skill to a poor quality of raw material in the form of ore.

I believe that any community must understand the basic principles of the industry by which it lives. I apply this with special force to the mining communities, which must recognize that any continuous prosperity must have as foundation the principle of intelligently making use of trained men and scientific methods. As for the engineer and manager, to be worthy of his title and to command the respect of the community for his training he must be alive to all the possibilities in his work; his methods must be cleaner cut and his results more certain. To too many, a mining education is merely a license to make a living in mining, without any recognition of the corresponding obligation to the state and the industry. To secure satisfactory results the community and the engineer must each recognize the obligations imposed and unite their efforts for the common good.

SUCCESS IN ENGINEERING

William R. Cox, who is well known as a successful mining engineer, in an address to the students of the School of Mines and Metallurgy, of the University of Missouri, at Rolla, Mo., on Oct. 24, 1911, under the title of "Some Suggestions to Mining Students," gave the following excellent advice, which the Engineering and Mining Journal endorses:

The problem confronting every engineer when he finishes the work required by his college may be formulated something like this:

Given my individual talents, such as they may be, and the training which I have received, what must I do to make the most of them in the long run? How may I develop myself, first, most thoroughly; second, most rapidly to the limit of my capabilities, and convert that development into confidence in myself, the respect of professional friends and the practical benefit of a successful career?

Many difficulties and some failures will be avoided if every one of you will ponder well this first practical matter, the importance of which will be brought home to you forcibly when I tell you that with all the hundreds of graduates turned out annually by engineering schools, every active operator is put to it continually to supply his need of competent, practical, young engineers. This statement you can verify for yourselves. It means that a large proportion of technical graduates do not develop as they should practically; principally because they do not know how to carry forward their education from the point at which the school drops it.

This scarcity of competent men spells opportunity for those young engineers who have the wisdom and earnestness systematically to prepare themselves practically as well as technically to fill the demand which never fails. Be certain that many operators are searching diligently at all times for the right men, and when someone tells you that your profession is overdone, remind him of Webster's remark about "room at the top." All important progressive operators, individual and corporate, have long since agreed that technical men are the best timber for development into managers and directors of large mining enterprises, and it is your responsibility to fit yourselves for the demand always existing for competent service.

Many graduates make the mistake of seeking at once work of responsibility, calling for experience and expert judgment, which they cannot in the nature of things possess. It is a serious misfortune for the young engineer and for his unwise employer when such a man is called to report upon prospects or mines or to recommend their development, equipment, method of operation, with valuations, estimates of working costs, profits and other data of similar character. The trained engineer with years of practical experience has difficulty in avoiding the mistakes, errors of judgment, and other pitfalls awaiting those who must do this kind of work. Do not court half successes or certain failures in permitting a desire for too rapid advancement to crowd you into undertakings for which you are professionally immature.

Avoid all short cuts which seem to promise success and reputation; set your feet steadfastly in the same logical road which attains the summit of the hill when you have climbed honestly and bravely with no attempt at running around the easy contours.

Now as to hill climbing:

I advise you every one to devote a number of years, more or less according to your aptness and your opportunities, to manual labor in every department of assaying, surveying, drafting, office and accounting, underground work, milling and construction. You will earn at least as much in practical work during this period as you would in minor technical positions, and you will come out with a grasp of your business which no man achieves who lacks the persistent courage to carry him through this invaluable apprenticeship. Much of this work and of the conditions surrounding it will be hard, rough and disagreeable; nearly impossible to men accustomed to luxury and soft living, but we cannot discuss the business of mining from a "pink tea" viewpoint.

With the preparation suggested you will be competent for the management of a modest property or for a position of limited authority and responsibility on a large one, and your steady advancement will depend upon your personal capacity and opportunities. You will know your business, and that is the main point after all.

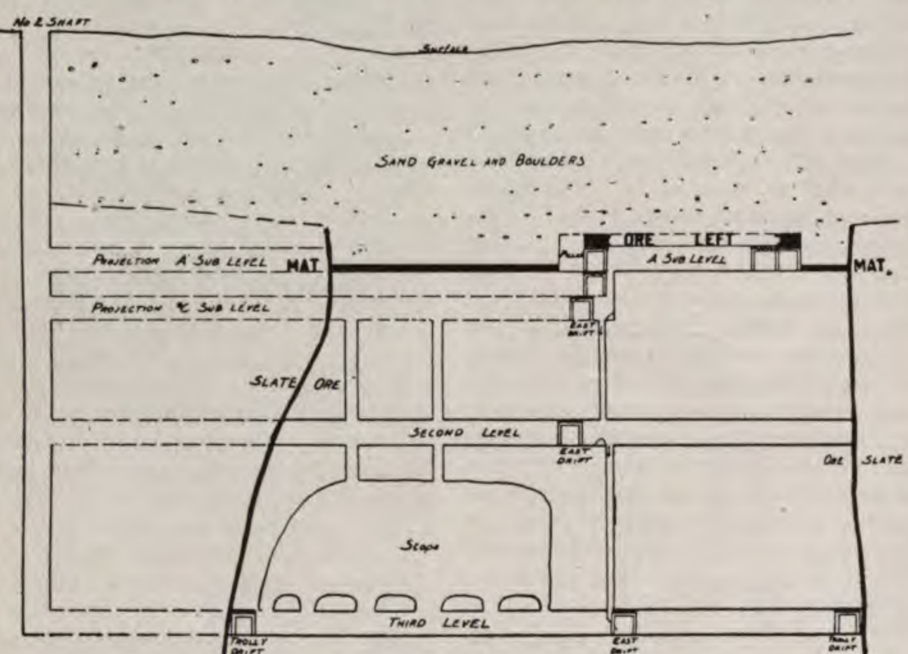
Be careful and methodical in keeping the notes given you in lectures and classes. This work is entirely neglected by a large percentage of students, with the result that much valuable time is lost when you are put to the practical test of gathering information in the field. My advice is to begin early in your college work a systematic method of compiling useful data. A diary supplemented with kodak pictures of plants, appliances, drawings and constructional work will be of assistance all through your professional life.

The carborundum crystals produced in the electric furnace are as hard or harder than the diamond, but they have always been of a dark color. Some success has been achieved in producing them of a colorless and transparent form even superior to the diamond in appearance. They are as yet brittle, however.

TOP-SLICING METHODS AT THE CASPIAN MINE

By WM. A. McEACHERN.*

The Caspian ore body was found in 1900 by churn and diamond drilling. The surface averaged 130 ft. and many of the holes were only chopped into the ledge to determine the best location for a shaft. In January, 1902, No. 1 shaft was started. This was a drop shaft and was landed April, 1902, with difficulty, on account of sand and water. The shaft was continued to 380 ft. From the shaft crosscuts were started on the second and third levels and continued across the ore body. Drifts east and west and then crosscuts, 50 ft. apart, parallel to the main crosscut, were continued to the rock. No. 2 was also a drop shaft and was sunk to the third level. This shaft is used for lowering men and timber.

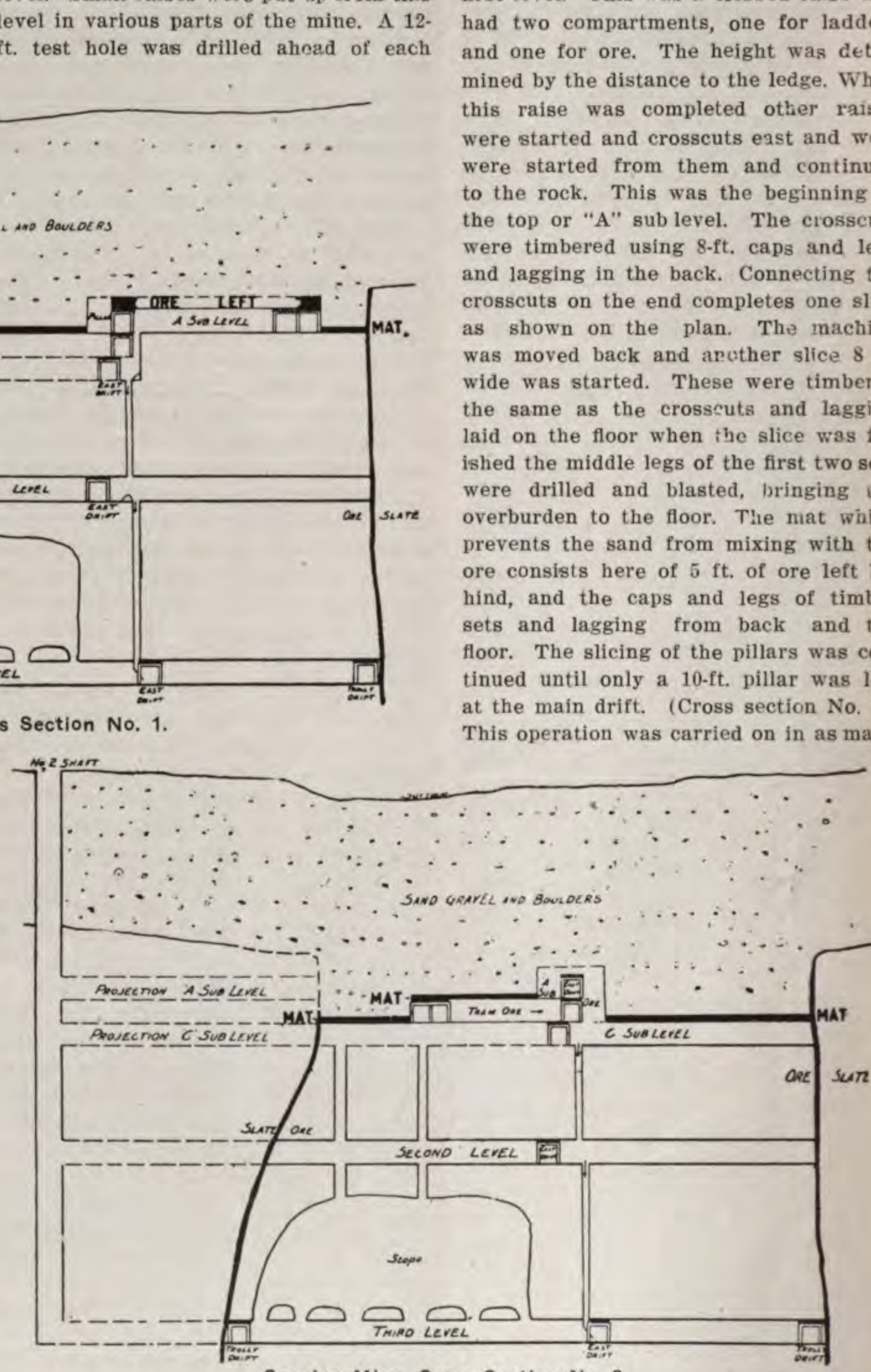


Caspian Mine, Cross Section No. 1.

Stoping—Between the second and third levels, nine stopes were opened up. These were started directly over and about 10 ft. above the back of the crosscut. The method used was back stoping; drilling holes into the back and blasting, then standing on the broken ore and drilling another round of holes. The average size of the stopes was 100 ft. long, 25 ft. wide and 50 ft. high, leaving a pillar of 25 ft. between the stopes.

Draining the Sand—The ore near the ledge could not be mined until the water was drained from the sand. Very little work was done on the first level, now called "C" sub-level, until 1908. This level was then extended and crosscuts started directly over the crosscuts on the second level. Small raises were put up from this level in various parts of the mine. A 12-ft. test hole was drilled ahead of each cut to ascertain the height of the sand, then 6-ft. holes were drilled and blasted. When the test hole reached the sand, 6 ft. holes were again drilled and blasted, leaving 5 to 6 ft. of ore to hold up the sand. Three more holes were drilled to hasten the drainage. Forty-eight raises were put in and some ran with little decrease in water for over a year.

Top Slicing—Top slicing at the Caspian mine is the method by which the ore is mined off at the top in slices 10 ft. thick and directly under the overburden. In June, 1908, a raise 20 ft. high was started from No. 5 east crosscut on the first level. This was a cribbed raise and had two compartments, one for ladders and one for ore. The height was determined by the distance to the ledge. When this raise was completed other raises were started and crosscuts east and west were started from them and continued to the rock. This was the beginning of the top or "A" sub level. The crosscuts were timbered using 8-ft. caps and legs and lagging in the back. Connecting the crosscuts on the end completes one slice as shown on the plan. The machine was moved back and another slice 8 ft. wide was started. These were timbered the same as the crosscuts and lagging laid on the floor when the slice was finished the middle legs of the first two sets were drilled and blasted, bringing the overburden to the floor. The mat which prevents the sand from mixing with the ore consists here of 5 ft. of ore left behind, and the caps and legs of timber sets and lagging from back and the floor. The slicing of the pillars was continued until only a 10-ft. pillar was left at the main drift. (Cross section No. 1.) This operation was carried on in as many crosscuts as the demand for ore required and pillars were left on each side of the main drift for the transportation of timber to the two succeeding sub-levels.



Caspian Mine, Cross Section No. 2.

"B" Sub-Level—The back of this level was even with the mat and is 10 ft. below "A" sub-level. On "B" sub-level

* Paper read at the Menominee Range meeting of the Lake Superior Mining Institute.

there were three points where the operation differed from "A" sub-level:

(a) No back holes were drilled as the ore stripped off the mat.

Caspian Mine—Plan of Sub-Levels.

(b) The timber was kept closely to the breast to hold up the mat.

(c) Boards were used on the floor instead of lagging.

No. 2 cross section shows "B" sub-level on the west side half drawn back, and on the east side finished with the exception of a 10-ft. pillar to support the drip. On the east side is also shown a crosscut in "C" sub-level ready for slicing. In any part of the mine slicing or crosscutting is not begun until the ore is taken out above it.

Sub Levels Between the Stopes—Within the next ten years, if one sub-level a year is finished, the sub-levels will be down to the stopes. The stopes must be filled with ore and trimmed and then crosscuts run between the stopes to the rock. The pillars will be sliced the same as before.

When the overburden is let down part will rest on the floor of the pillar and part on the filling in the stope. It will be necessary to carefully watch the chutes to the stope as lowering the filling might ruin the mat and allow sand to mix with the ore.

SIMPLE METHOD OF SEPARATING ROCK FROM CLAY

By F. A. KILLIK.*

The method herein described was installed at the Totok gold mine, Celebes, Dutch East Indies, for the purpose of separating a large proportion of stiff, wet clay from the ore delivered to the mill. This clay occurs with the quartz and formerly gave great trouble in the bins, breakers and automatic feeders. The ordinary puddler did not prove a suitable machine for effecting the necessary separation, on account of its high cost of installation, heavy running charges and other drawbacks, and therefore it became necessary to find a better method. Owing to the fact that water under pressure was available at the mine, the present plant was devised and has proved eminently satisfactory in the reduction of labor and other costs, besides being beneficial in other ways. The author is not aware that any description of a similar method has been published and hopes that a detailed account of the process may be of use to others confronted with a like difficulty.

GENERAL DESCRIPTION OF PLANT.

No. 1 Plant—Fig. 1 shows a strongly constructed V-shaped hopper A, made with watertight joints and set at an angle of 25 degrees to the horizontal; the front or mouth of this hopper is 4 ft. wide and is closed to within 2 ft. of the level of the washing plate B. Six inches in front of this is an adjustable board C 10 in. wide, set so as to form a space between it and the plate B, which is 4 ft. wide, 4 ft. long and has a fall of 3 in. It is boarded in at the sides from a height of from 3 to 4 ft.; fitted under the forward end is a grizzly D 4 ft. in width, set at an angle of 45 degrees, the bars of which are 10 ft. long and spaced ¾ in. apart.

The ore bin E is placed 18 in. below the grizzly at an angle of about 38 degrees from the horizontal, the boarding around the bin being extended up both sides of the grizzly. The bin front is of the usual construction, fitted with an adjustable door and butterfly in the chute.

The timbers carrying the washing plate are extended some 15 ft. and supported by the front posts of the bin. Upon this extension is the operating platform F about 18 in. above the level of the washing plate. A pipe line is provided, terminating in a nozzle G controlled by a valve. The nozzle G of the washing pipe is afforded change of direction by means of a ball-and-socket joint of simple construction, the details being shown to scale in the sectional drawing; it wil be noticed that the ball-and-socket joint is kept tight when the high pressure water is shut off by means of a spiral spring that keeps the two parts in bearing. A lever is clamped closely to the nozzle for the purpose of directing it where required; this is attached in position by a bolt on a bridge support in the same manner as is practiced with hydraulic monitors. A ¾-in. pipe H, with a controlling valve, is taken off the pipe line at a convenient point before it reaches the nozzle, and this pipe is carried up above the hopper, over which it is extended by a right angle bend provided with perforations, for the purpose of spraying the material as it is dumped into the hopper from the trucks above.

A waste rock "sollar" is built below in a convenient position for sorters. Immediately under the grizzly compartment is a wide launder K, closed in to prevent loss from splashing, the bottom being well inclined to one side, where it is narrowed down and connected with a launder leading to settling tank L.

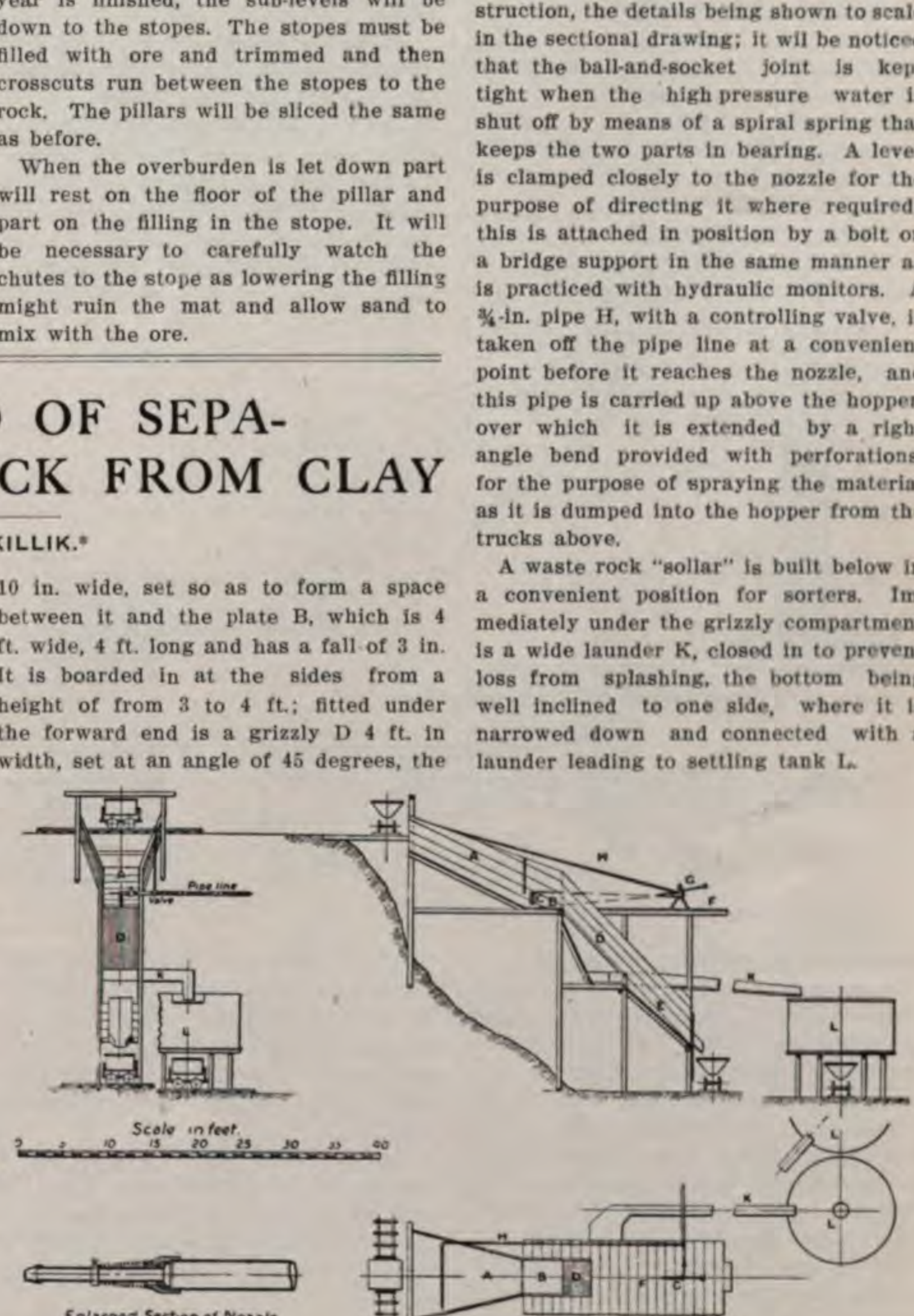


Fig. 1.

The hopper A, as also the sides of the grizzly compartment and bin, are lined with ⅛-in. flat steel sheets; for the bottom and sides of the washing plate B old side plates from mortar boxes are used. The settling tanks L are of the usual construction, with filter bottoms

* Bulletin No. 87, Institution of Mining and Metallurgy, London.

and bottom discharge doors, and of a size and number suitable to the capacity of the plant.

The total height, as shown in Fig. 1, is 28 ft., but to meet the circumstances of the installations the measurements may be reduced in the following respects. The hopper may be shortened, the grizzly cut down to 6 ft., or somewhat less, and the ore bin below the grizzly set at an angle of 35 degrees and shortened.

Plant No. 2—This varies from that already described in having a fine, removable screen M, under the grizzly and a baffle-board N, set at right angles to the latter to throw sands on to the screen; a second small bin R, to take the product remaining on the screen, together with shaking tables O, and blanket tables P, as shown in Fig. 2.

OPERATION OF THE PLANT.

If a large quantity of ore has to be handled it must be ascertained if the fines (say the material passing on 8 or 10-mesh screen, after contact with mercury on the shaking tables, are worth collecting and milling. If so, the plant would be constructed according to the arrangement shown in Fig. 1, using the grizzly only, with settling tanks. If, on the other hand, the fines be poor enough to discard after mercury contact, an 8 or 10-mesh screen must be placed immediately below the grizzly, as shown in Fig. 2. The fines passing the screen are led to shaking tables, the first two compartments of which contain mercury, and they are run at a speed to give some 200 shakes per minute. After this treatment the sands are run over a wet blanket table and thence into the catch-box.

Should the material to be treated contain but a small percentage of rock, and this not of sufficient size to act as a disintegrator on the plate, rock must be added to this point, and the opening exposed to the water jet diminished to prevent too rapid feeding. The larger pieces of rock on the plate may be retained there by a few bars through which the fines and water pass.

The material dumped into the hopper is subjected to a constant spray of water by means of the sprinkling pipe H, which thoroughly moistens the clay and aids the subsequent disintegration of the charge when it is attacked by the water jet.

When the hopper is well filled water from the nozzle is caused to play upon the opening; the rock washed out lies on the washing plate and sets up a grinding action upon the material. As the washing process continues, the rock accumulates on the plate and is gradually worked forward until it drops into the bin below, the fines and water passing through the grizzly, whence they are conveyed by launder to the settling tanks. The hopper should be well supplied during the time of filling the settlers, and the flow of water maintained in order to prevent settlement of slimes in the tanks which would hinder their subsequent draining.

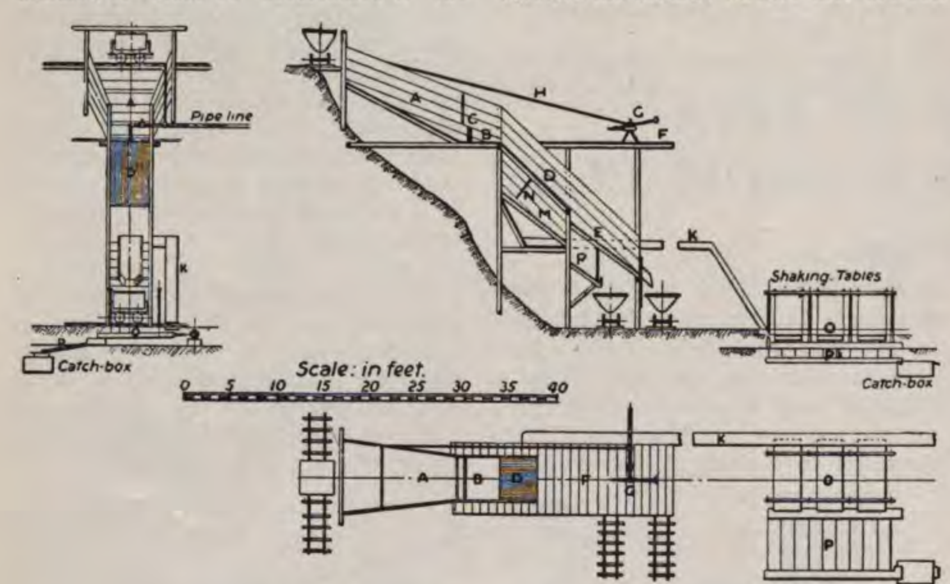


Fig. 2.

The material actually being treated at the mine with one washer is about 200 tons per 24 hours, and consists of:

Rock retained upon ¾-in. grizzly, 30 per cent assaying 10 grams of gold per ton.

Fines passing grizzly, collected in settling tank, 23 per cent, assaying 16 grams.

Waste rock sorted out, 7 per cent.

Slimes discarded, 40 per cent, assaying 1 gram.

The pressure of water at the nozzle is about 125 lbs. per square inch, but if necessary a lower pressure could be used efficiently. A ⅞-in. nozzle is fitted, but the valve is never opened full, from 15 to 20 cu. ft. of water per minute being used.

Cost of treatment per ton, based on 200 tons per day actually treated. Labor at eight hours per day:

	s.	d.
Hydraulicking (3 natives at 1s per day)	3	0
Sorting and trimming (12 natives at 10d per day)	10	0
Discharging tanks (4 natives at 10d per day)	3	4
Total	16	4

On total amount treated, equals 0.98d per ton.

On total amount recovered, equals 1.8d per ton.

The cost of treatment by the older method, with puddlers and shaking tables (on contract), upon the basis of 400 tons daily of material, containing 21 per cent rock, 6.5 per cent sands, 10 per cent waste sorted out and 62.5 per cent passed away over shaking tables, was, on total amount treated, 3d per ton, and on the total amount recovered 11d per ton.

Upon this material the costs under the new method would be:

On total amount treated, equals 0.92d per ton.

On total amount recovered, equals 3.2d per ton.

These figures do not include the power for driving the puddlers, etc., required by the older method, which would amount to 0.6d (per ton) of material treated, and 2d on the product recovered.

The disadvantages of the older system, compared with the new, were:

1. Higher first cost.
2. Power required to drive puddlers.
3. Great wear and tear of plant.
4. Increased labor.
5. Lack of continuity.
6. Increased time required for cleanup.
7. Excess of water required.

The advantages of the new method are:

1. A continuous plant working almost automatically.
2. No gold settling anywhere except in the tanks or upon the shaking tables.
3. Uniform flow of water, facilitating good running of the tables.
4. Minimum wear and tear.
5. Constant feed of rock into bins, assisting sorting.

In Boston there is an equivalent of 1,232 16-candle power electric lamps for each 1,000 of population; in New York, 859; in Chicago, 730, and in San Francisco, 660. European cities show much smaller figures, St. Petersburg having 440, Vienna 246, Paris 185 and London 184.

ines and Methods

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CONTENTS:

announced that the Utah-Karns ing Machine Co. is going to sup- machine for the running of a real my-heart-and-hope-to-die) tunnel Newcastle Reclamation Co., down county, this state. The tunnel is nearly a mile in length and it is ed that about 1,000 feet a month driven. If we remember correct- Utah-Karns Tunneling company d to run a tunnel in the Snake district, south of Park City, for Jesse Knight a few years ago; but, than the boosting that was given mpany and its machine by the ex- ion of the "contract," nothing came The announcement this time car- out the same odor that emanated he Snake Creek deal, and we no- at great stress is being laid on the f this contract in the tunnel com- stock-offering advertisements.

FORTHCOMING REPORT OF UTAH COPPER CO.

Before another issue of this magazine will have made its appearance, the annual report of the Utah Copper Company should, if custom is followed, be in the hands of shareholders. Judging from previous compilations and the character of information that has been "released" from the company's publicity bureau and palmed off on the public through "stock market letters" and the subsidized press, the document will be equally as remarkable, in point of ingenious construction, as any of its predecessors and, as was the case one year ago, the shareholders are going to be officially informed that ANOTHER TREMENDOUS INCREASE IN THE AMOUNT OF DEVELOPED ORE HAS BEEN ADDED TO THE RESERVES. In order to pave the way for this announcement and to prevent, as far as possible, the sharp criticism that must come from those who have been kept in ignorance of what has been going on during the past twelve months, the company's press bureau, about the end of February, worked off on the Boston News Bureau and other "purveyors of news" a story the SEEMING object of which was to compare Utah Copper with Amalgamated shares as an investment—to the great advantage of the former, of course.

Two-thirds of the way down through the story referred to, without even beginning a new paragraph, or treating the matter as anything more than a presentation of the figures to make the showing desired in the discussion of the respective merits of Amalgamated and Utah Copper, is the following innocent and unobstrusive sentence: "The directors of the company HAVE STATED PRIVATELY (the caps are ours) that Utah Copper has RESERVES of 300,000,000 tons of ore, or an amount to last forty-three years, treating 7,000,000 tons per annum."

The use of so much space for the surreptitious promulgation of this bit of news, and the use of an imaginary inquirer upon whom to expend the energy, makes it worth while for Mines and Methods to quote the News Bureau fully, as follows:

It is not an easy matter to make the comparison mentioned in your communication, as it might almost be said that there is no such thing as "actual values" as applied to copper stocks, there are so many contingencies which must be allowed for, such as varying recoveries from the ore, varying costs of recovering the refined copper and varying prices at which the product must be sold.

In the case of the porphyry mines, fairly accurate determinations can be made as to the size of the ore body and the copper contents thereof. With these figures in hand estimates can, of course, be made as to earnings on various prices for copper, barring, of course, accidents and interruptions to operations. The vein mines are not able to give any esmate as to the life of their ore bodies, as it is impracticable from a mining standpoint to make openings too far ahead of extraction.

These are factors which must be borne in mind in any attempt to make the comparison you request. Then again, Amalgamated is not a "mining property," it is merely a corporation holding the shares of other companies.

We will endeavor, however, to give you a brief comparison along the lines suggested:

Amalgamated has outstanding 1,538,879 shares, and against this capital there is in the company's treasury 3,132,500 shares of Anaconda, or better than two for one. It also owns the United Metals Selling company. In addition the company has a surplus of $4,000,000 in net cash assets.

Anaconda can earn $3 per share on 14-cent copper assuming its annual production to be 275,000,000 pounds of copper. Amalgamated, therefore, is showing just now an earning capacity of $6 per share, or 9 per cent on the present selling price of 67.

Utah Copper is showing an earning capacity of about $4.50 per share, or 8 per cent on a selling price of 57. Demonstrations as to the future, however, can be made with respect to Utah Copper, which cannot be made with respect to the Amalgamated. The directors of the company have stated privately that Utah Copper has reserves of 300,000,000 tons of ore, or an amount sufficient to last forty-three years, treating 7,000,000 tons per annum.

It is costing the company not far from $1.50 per ton to "strip" the mine, transport, concentrate, smelt, refine and sell its product. On 14-cent copper there should be a profit to the company of $1.30 per ton. Applying this profit to 300,000,000 tons, there works out prospective profits of $390,000,000, or $241 per share on 1,-619,000 shares—all bonds converted.

Thus, it is apparent that the company has an average earning capacity on 14-cent copper of $5.50 per share for forty-three years. According to the amortization tables these profits reinvested at 5 per cent give the stock a present value of $96.50 per share.

Of course there is much that is theoretical and academic in these calculations, but nevertheless they are the calculating methods of conservative experts, the only fluctuations to occur in the final profits being those dependent upon the fluctuating price of copper. Fourteen cents is generally recognized as a fair average, as this is the price at which copper has averaged over the past ten years.

With Utah Copper at 57 and average

profits of $5.50 per share per annum, the return on the present selling value is 9½ per cent. Utah Copper has not as yet reached its maximuum capacity, and in view of the calculations which can be made on the basis of present claimed ore reserves, there would seem to be greater security to the investor in the purchase of Utah Copper than in the purchase of Amalgamated with its indeterminate "life." No account of course is taken of the speculative possibilities of either.

Anaconda, which forms the basis of all Amalgamated's calculations, is assumed to have a productive capacity of 275,-000,000 pounds per annum, at a cost of 9 cents per pound. Utah Copper is estimated to have a productive capacity of 140,000,000 pounds of copper per annum at a cost of close to 7½ cents per pound.

Even those who keep in touch with the Utah Copper Company's affairs and who are familiar with the easy methods they have of increasing developed tonnages—on paper—will experience some surprise when reading that during the year 1911 the mine's resources expanded from a trifle more than 200,000,000 tons (as officially claimed in last year's published report) to 300,000,000 tons. And many will wonder how such a seemingly impossible thing could happen without the market getting so much as a breath of what was doing—or had been doing—until a few weeks previous to the issuance of the annual report. Possibly we can throw a little light on the subject in advance of the official promulgation of the news.

Of course the company will not claim that this new tonnage has been developed as a result of steam shovel operations—it can hardly be expected to do that in the face of the reports during the year which acknowledged that stripping was not developing reserves fast enough to permit of a cessation of the underground methods of mining. As a matter of recorded fact it was necessary during the year to obtain a constantly increasing percentage of ore for the mills by underground methods, the last quarter averaging 27% of the total tonnage handled. This percentage was increased to 36 in January of the present year, while the rate for February was fully as high, as we have previously shown.

Such being the case, we must look elsewhere for an explanation of the development that has made such an enormous new tonnage of ore available during the last twelve months; and that necessitates disclosing what has evidently been cherished as a state secret by the Utah management, so that the news might be sprung impressively in the annual report, and so account for the new reserves of 100,000,000 tons.

A short time ago the Utah Copper Company completed the sinking of a drill hole some 900 feet deep on the line of the limited brecciated zone which borders the Quinn fissure, and claimed that values had been encountered all the way down. This drill hole is located at a point about 300 feet northeasterly from the point of junction of the Quinn fissure with the stronger mineralized zone which deflects to the northwest, passing obliquely across the easterly end of the Barnsdall ground into Col. Wall's Alamo-Jay Gould groups and on into the Highland Boy, as heretofore particularly decribed and illustrated with maps and photos in this journal, and upon which all steam shovel and underground mining operations have been directed for the past eighteen months.

This drill hole is located less than 300 feet westerly from the boundary lines of Wall's Starless group, through and beyond which, to the east, the Quinn fissure has been developed in the Bingham-Butte company's property, where a tunnel is now being dirven to demonstrate its value at greatly increased depth, and where exploration is relied upon to bring additional substantial results, results which seem to be assured by this new drill hole development.

As to results obtained from sinking this particular drill hole we defer to the Utah Copper Company the privilege of first publication. It is evident, however, that if ores of commercial value have really been discovered by this development, their extraction must be by some method other than by the steam shovel. The facts are, however, that this is merely a "scout" hole, sunk for the purpose of information as to the character of ground in the immediate vicinity of the underground drift or tunnel which is now being extended from the Mascotte tunnel of the Ohio Copper Company to a connection with the Hayden drill hole, sunk from the bottom of the "big pit" and which connection is now so nearly completed as to begin to draw off the water which has heretofore obstructed the operation of shovels in the bottom of the pit.

This extension of the Mascotte tunnel, insofar as it has penetrated Utah ground, and which will shortly intercept the Hayden drill hole at about 800 feet below the surface of the pit, is being exhaustively sampled by a corps of experts in charge of Engineer Henry Crumb, evidently in the employ of someone other than the Ohio Copper Company, so that announcement may soon be expected that arrangements have been made for transportation facilities and underground mining methods—from the Quinn fissure zone.

Thus we have the first evidence of a resort to sane methods of mining Utah ores. But, as we have repeatedly heretofore shown, this departure will leave the Bingham & Garfield railroad, with its terminal ramifications, from 1200 to 2000 feet UP IN THE AIR, and about three and one-half miles distant from the point at which the ores will reach the surface on a branch of the lines of the Rio Grande railroad, which serves the Ohio Copper mill.

HOW TO FIGURE PROFITS

In these strenuous times no paper that lays claim to being up-to-date in its mining news department fails to do its best in "plugging" for the "dissiminated porphyry" mines. They know something is expected of them and they strive to make good. They frequently get off wrong—sometimes when they know better, and at other times when they don't.

On the morning of St. Patrick's Day the Salt Lake Tribune's mining department, under the displayed headlines reading "Profit Not on Tonnage Figures; Occurrence of Ores Must Also be Taken Into Consideration," offers the following symptoms of the writer having listened to the befoggled argument of a night-outer. If you cannot quite make out what the writer, or the "mining man" he is supposedly quoting is trying to get at—take another drink and try again. Here is the "dope:"

A new feature of the estimated earnings of the porphyry coppers has been brought out by a Salt Lake mining man, who says that the developed tonnages and estimated profits cannot be always ascertained under stated given costs of production, for the reason that under different mine conditions the costs of handling are increased or decreased according to the occurrences of the ore. If a certain tonnage is developed and the costs of handling are accurately ascertained, these costs need not apply to all parts of the mine. Should the ore be found scattered over a large area, it is obvious that the mining costs will increase in proportion to the amount of work necessary to get at the deposits. Once the deposits are reached, then, of course, the dead work is passed and will be practically nil as long as the work continues in the ore body.

On the other hand, if the ore is found in lenses in different parts of the territory and it takes considerable driving to get to them, the profits are not as great as if the deposits were continuous. Again, if the ore is demonstrated to be continuous over a large area, the extraction costs are reduced. These facts must be taken into consideration, it is argued, when estimating profit on disseminating ore. Under given conditions a mine with half the tonnage of another property may be as valuable as the larger property because of the reduced costs of extraction and the concentration of the work. This condition calls for the ore to be all in one deposit and mined in a systematic and economical manner.

While in making estimates on the earnings of different properties the mining costs have been figured as an average to meet all conditions, yet the same costs of handling cannot be applied to different properties which have the same grade of ore and occurring in like quantity, because the distance between the different ores must be taken into consideration before a logical estimate can be made.

This difference in costs of handling and in ore occurrences is shown by the records made by some of the porphyries to date. Up to the present time, Utah Copper, Nevada Consolidated and Chino have been demonstrated to be the only steam shovel propositons. The lowest cost will probably be attained by Chino, since it is already operating at a cost of 7 cents per pound for the copper produced. At one time, by using the profits from the Nevada Northern ralilroad, Nevada Consolidated showed a cost of about 6 cents, but is not producing at this rate at present. It is true that the ore at times is

lower grade on account of surface ores coming in, but as the work progresses, this difficulty is overcome to a great extent.

Of the properties that have lower grade ores underground where caving systems must be used, the argument brought forth in the costs of getting to the ore holds true perhaps to a greater extent. Here the difficulty is likewise encountered in getting a clean product, and when waste comes in that waste must be hoisted. But the idea of the costs of getting to the ores is emphasized, for in a body such as the Miami, which is of a little better grade and more compact than some others, it is brought out that greater profits can be made.

With these facts as a working basis, the estimates made on developed tonnages must be estimates made on the ore occurrences and the ability to get the output mined in the most economical manner.

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In answer to several inquiries as to the location of the much-talked-of new gold camp of High Grade. It is located in the extreme northeastern corner of California, almost on the line between California and Oregon, and about eight miles from New Pine Creek, a station on the Nevada, California and Oregon railroad which, according to the maps, is on the Oregon side of the line. Colorado, Nevada and Southern California interests appear to be doing the boosting for the district, which is claimed to be full of merit and due for a boom this spring, after the snow is gone.

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In Sydney last month, on two successive days, two workmen were electrocuted. One man was a rock-driller working on the sewer outfall works at Long Bay, and his death was caused by the current short-circuiting with a rock-drill which he was handling. The second case was that of a fireman employed at Saxton and Binns' timber yards at Pyrmont. He was carrying a small flexible extension electric hand lamp, when, owing to a short circuit occurring, a current of 240 volts passed through his body, death being instantaneous. Such accidents are fortunately of rare occurrence, but they serve to show the necessity for all electrical apparatus to be properly insulated and carefully installed.—Australian Mining and Engineering Review.

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The use of uranum and its compounds are relatively few and not extensive, the principal use being in the manufacture of yellow glass and for yellow glazes for pottery and to a small degree as a chemical reagent. The attempt to use uranium in steel manufacture seems to have been given up as it apparently imparts about the same properties as tungsten and is very much more expensive.

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Linseed oil added to whitewash adds to its durability. Sulphate of zinc and salt help to prevent flaking.

UNUSUAL SOLICITUDE OF UTAH COPPER COMPANY IN BEHALF OF COL. WALL

R. C. Gemmell, assistant general manager of the Utah Copper Company (whose picture is here given) put another "hot one" over Col. Wall recently when he secured an order of the judge of the Third District Court granting exclusive possession of a strip of Col. Wall's Car Fork property about 3,500 feet long, for the purpose of constructing a high voltage electrical transmission line. The route selected is over that portion of the grounds alleged by Col. Wall to contain his most valuable deposits of copper minerals, and in and upon which his chief mining development work is being directed. The line also occupies a central position over and across that part of Wall's property which has heretofore been appropriated in like manner for the dumping of waste or overburden from the Utah Copper property. The line branches out from the company's transformer station, which is upon grounds theretofore donated to the Utah Copper Company by Col. Wall and is reached by the main power line extending from the Magna plant, the last 3,000 feet being upon a circuitous line located upon and passing over Wall's Starless property in Main Bingham, the right to construct which was also granted by Col. Wall without any consideration or value.

The objective point to be reached in the construction of this new line is stated in the bill filed in the District Court as the town of Upper Bingham. Now, the distance from the transformer station to the terminal station indicated, in the town of Upper Bingham, in a direct line over grounds owned exclusively by the Utah Copper Company, is about 3,000 feet and a line constructed upon this route would be comparatively straight, following the bed of the gulch and county road, where no steam shovel operations or surface mining is contemplated or possible. To reach Col. Wall's Carr Fork property it was necessary to branch off at something more than a right angle to the north from the direct course to the objective point, as indicated, passing over property owned by the Utah Copper Company and other parties for a distance of about 2,000 feet. From the point at which the line leaves Col. Wall's property the distance to the terminal objective point, as stated, is probably 7,000 feet, the lands being owned by the Utah company, but situated outside of its mineral belt; so that, in order to reach a point from which the people of Upper Bingham are to be served, as stated in the petition, a distance of nearly two miles is traversed in preference to the direct line before mentioned to Upper Bingham.

An interesting feature of the testimony upon which the order of possession was procured consisted in a letter written by Manager Gemmell to H. C. Goodrich, chief engineer of the Bingham & Garfield railroad and the Utah Copper Company, which was read to the Court and which, in pathetic terms, enjoined Chief Engineer Goodrich, if possible, to select a route for the desired line without further intrusion upon the property of Col. Wall, and in an earnest effort to carry out the wishes of Manager Gemmell Chief Engineer Goodrich declared, under oath, that he had exhausted his entire engineering ability without result, other than as before indicated.

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According to Consul General Thomas Sammons of Yokohama, a new process for the electrolytic recovery of zinc has been successfully worked out by Chitaro Yoshida, the proprietor of a copper mine in Iwashiro province, Japan. The zinc ore is dissolved in the electrolyte, and from this liquid the zinc is precipitated by electrolysis. The process is simple, but several obstacles have been found. For instance, the presence of a small particle of copper, antimony or arsenic is enough to render the process futile. One of the defects of the process heretofore has been the spongy form of the zinc which adhered to the cathode. To prevent this carbon was tried instead of lead in the anode. The carbon was coarse and dissolved in the sulphate of zinc, and the zinc which gathered on the cathode was then found to be refined to a degree rarely surpassed by the imported metal. During 1910 Japan exported 24,747 tons of zinc, valued at $383,485, and imported 11,581 tons.—Mining Science.

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At Stratton's Independence mill, in the last fiscal year, the wear and loss of steel in the chilean mill rolled-steel tires was 0.43 lb., and in the dies 0.19 lb. per ton of ore crushed.

determine the relative economy of rolls for pulverizing when compared with the tube mill and other types of grinding apparatus.

ROLLS FOR COARSE CRUSHING ARE BEING MADE HEAVIER.

Irrespective of the part which rolls may play in the future in their relation to the two extreme limits of size reduction, there is no doubt that they have achieved for themselves a secure position in crushing products of intermediate sizes. This is partly due to their large capacity and low cost of operation. It is also due to the fact of their mechanical simplicity, which involves the principle of the toggle lever in overcoming crushing strains exerted by particles brought within the angle of nip of their surfaces. Since their revolving masses also serve to absorb their own "peak loads" when properly fed, a moderate and fairly uniform application of driving power is able to accomplish a considerable amount of effective work in splitting and shattering rock fragments.

Perhaps the most distinctive advantage of rolls is that their construction permits them to apply the principle of "arrested crushing" to a greater range of sizes than is possible with any other type of crushing apparatus. The crushing pressure exerted by the opposing roll surfaces during the angle of nip is instantly released and ceases when the rock fragments reach the horizontal diameter of the rolls, where the open space between them permits the material to be discharged. Roll crushing thus permits most careful and accurate stage reduction within a wide range of sizes, and avoids pulverizing and sliming an undue amount of the softer minerals of an ore, in crushing it to the size at which they will unlock sufficiently from the inclosing gangue to permit their being concentrated. For those ores, therefore, which require concentration, the use of rolls in preparing them for jigs, shaking tables, or magnetic separators has become almost the universal practice. This applies to many iron, copper, lead and zinc ores. Gold and certain silver ores, both those which require concentration and those which do not, are in a class by themselves.

The modern tendency to reduce milling costs by increasing the mill capacity has demanded a greater duty from rolls than ever before, and in the larger mills rolls are now employed from 36 in. up to 54 in. diameter, and from 15 in. to 28 in. width of face. Such rolls are used mainly for coarse crushing; that is, they take the product from the jaw or the gyratory crusher of 1½ to 2½-in. size, and reduce it to about ½ in. These coarse or No. 1 rolls are then followed by other rolls, set closer together for finer crushing, and possibly by others which re-crush certain middlings products obtained in the process of ore treatment, or even tailings, dependent upon the nature of the ore and its association. Rolls of this general character require massive construction and excellent workmanship. Rolled-steel tires can now be obtained up to 54 in. diameter. Special hard steels, such as chrome and manganese steels, are also used for certain ores, either in the form of tires or of plates bolted to a central mandrel. In this way the life of the crushing surfaces has been much prolonged.

Marked progress has thus been made within recent years in the field of coarse crushing by means of rolls, in response to the greater demands of modern mill practice, and this progress has been largely brought about by increasing the dimensions of the rolls and adopting a more massive construction, as well as a better design, combined with a wider choice of steel adapted to different ore requirements than has heretofore been available.

ROLLS FOR FINE GRANULATION NOT YET PERFECTED.

On the other hand, it must be admitted that up to the present time rolls designed for fine crushing, where the ore requirements demand a maximum granulating effect and a minimum pulverizing or sliming effect upon the crushed product, have made little progress compared with rolls designed for coarse crushing. In fact, rolls, as heretofore designed, can hardly be said to have held their own; and since little assurance of their satisfactory operation can be had in connection with an ore which must be reduced to pass a 20 or 30-mesh screen while retaining the crushed material in a granular condition, rolls have been assailed on all sides by various types of ball mills and other pulverizing apparatus, which claim to accomplish the function of granulating an ore successfully, but usually by means of some reduction in the time during which the pulverizing effect takes place. While there may be an overlapping territory at the limit of fine granulation where pulverizing apparatus may be so adjusted as to perform the function of approximate granulation with sufficient success to make their use advisable, yet it is clear that a crushing force exerted upon material placed between walls which do not touch when at their minimum distance apart, must produce a distinctly better granulated product than when it is crushed between walls which are brought into physical contact with a grinding pressure.

With the presumption of advantage thus on the side of rolls, even
the finest sizes, the fact remai
heretofore rolls have proved un
tory and inefficient, from lack of
over the granulating action as
faces wear, and also from their s
pacity.

In looking more closely into th
of this inefficiency, it is evident
effect of the irregular wear of
faces becomes a more serious m
fine crushing than in coarse crus
the reason that in the former, s
faces must be brought quite c
gether, the ratio of the sectional
to irregular wear to the total are
ing between the rolls is greater
the latter case. Hence any
grooving, or corrugating of the r
permits a considerable proportio
particles in the feed stream whi
the depressions to pass between
without being crushed. This red
capacity of the rolls, measured
amount of undersize or finished
obtained. Another difficulty arisi
irregular wear of the roll faces i
the fact that when out of par
rolls tend to exert a certain co
of the crushing pressure at righ
to the diameter of the rolls, o
direction of the axes of their sha
produces an end thrust upon
shafts, which, transmitted by m
collars to their bearings, causes
heat and the shafts to cut, thus a
power wastefully, and still fur
ducing the crushing efficiency a
ured by the power consumed to
the rolls in relation to the am
finished product obtained.

Rolls used for fine crushing th
a decreasing efficiency in propo
the wear of their roll faces until
is reached where it becomes n
to stop the crushing operation,
restore the faces by chipping,
or machining them until their
are parallel. This involves loss
and of mill capacity, besides exp
a wasteful use of the roll shells.

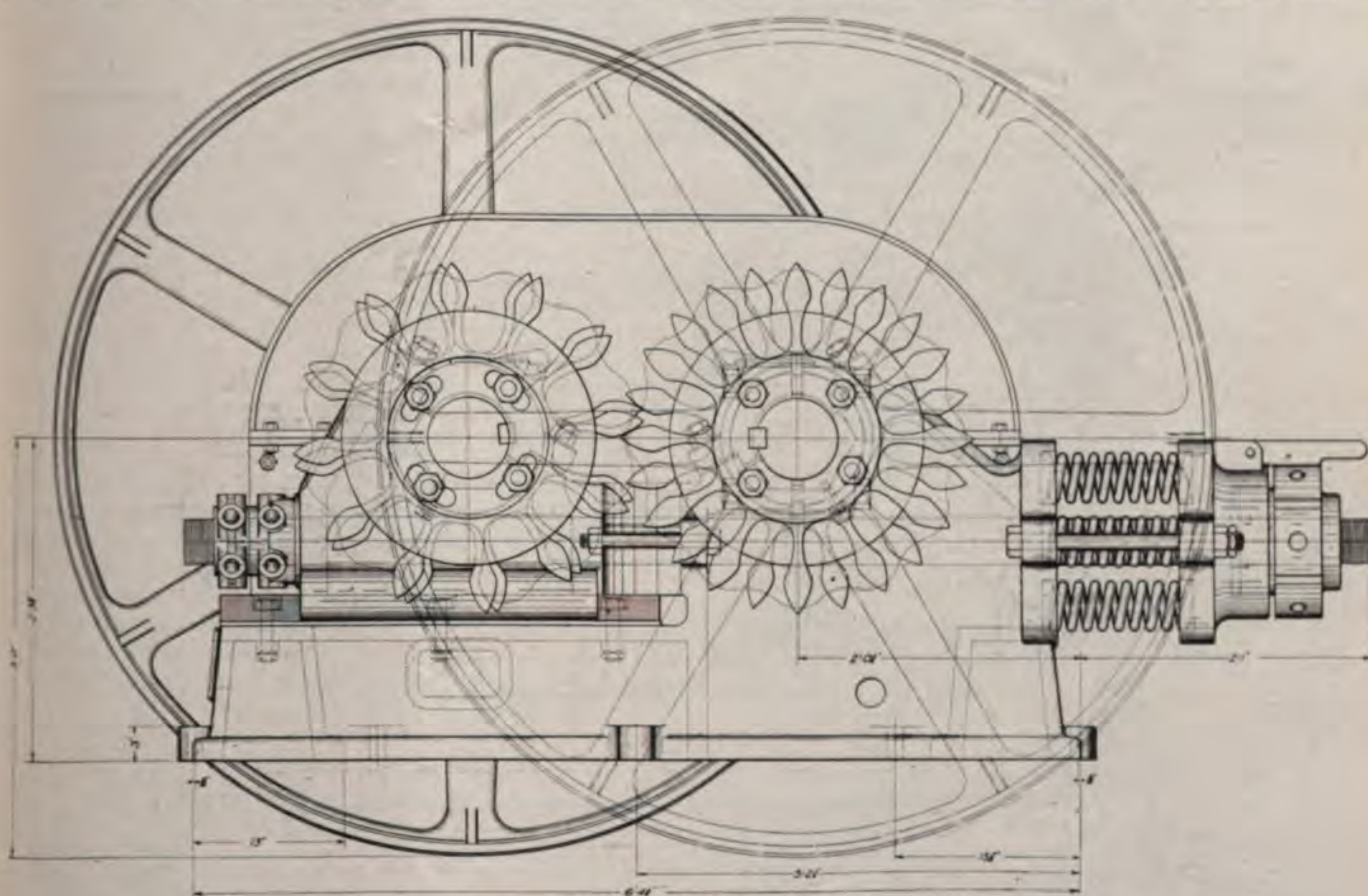
While a certain amount o
crushing is usually advisable
crushing, in order to offset som
capacity, the best results can on
tained, where the prime obje
granulate an ore, when the roll f
maintained parallel, and when
consists of sized material in
avoid packing and pulverizing it
ing it between the rolls. It see
from the above considerations
ther advance in the art of fine
tion by means of rolls can onl
pected by means of certain ref
of function whereby the roll face
maintained parallel while they
wear.

THE WALL CRUSHING ROLLS.

The Wall crushing rolls are of two types—corrugated and plain straight faced—similar in construction in every respect, so far as the crushing parts are concerned, to the Cornish rolls referred to by Mr. Payne, except that one roll of the latter type is mounted vertically above the other, as is clearly shown in the accompanying drawings.

There is now in operation at the Ohio Copper mill twelve pairs of the corrugated rolls and eight pairs of the vertical type, the corrugated rolls being utilized for a coarser crushing, superseding a large and small type of disturbing, so far as practicable, the daily output of the mill.

The corrugated rolls are 30 in. in diameter by 20-in. and 3 in. thick and are driven at a speed of about 125 to 150 revolutions per minute. The shells are manganese steel and the rolls are geared together with cast-steel finger gears so as to keep the corrugations of each shell in proper mesh with the other. They were originally placed to receive the product of Blake crushers which delivered sizes from cubes of 2½ in. down and were set to crush to about ¾ in. But subsequently the Blake crushers, which were of two stages, were discarded and type, it may be said that prior to discarding the Blake crushers the first pair of corrugated rolls installed was fed with the Blake crusher product, ranging in sizes from about 1¾ in. down—as the same was delivered from an elevator with an excessive flow of water—at a rate stated by the manager of the mill at 1,000 tons a day, the entire product being reduced to ¾-in. and smaller. Under these conditions the rolls were operated for nearly five months and were subsequently placed to receive a smaller product (of about 1 in.) and upon this have continued to operate for about three months longer, and are still in operation



(PATENTED APRIL 4, 1911)

Wall's Improved Corrugated Crushing Rolls—Side Elevation.

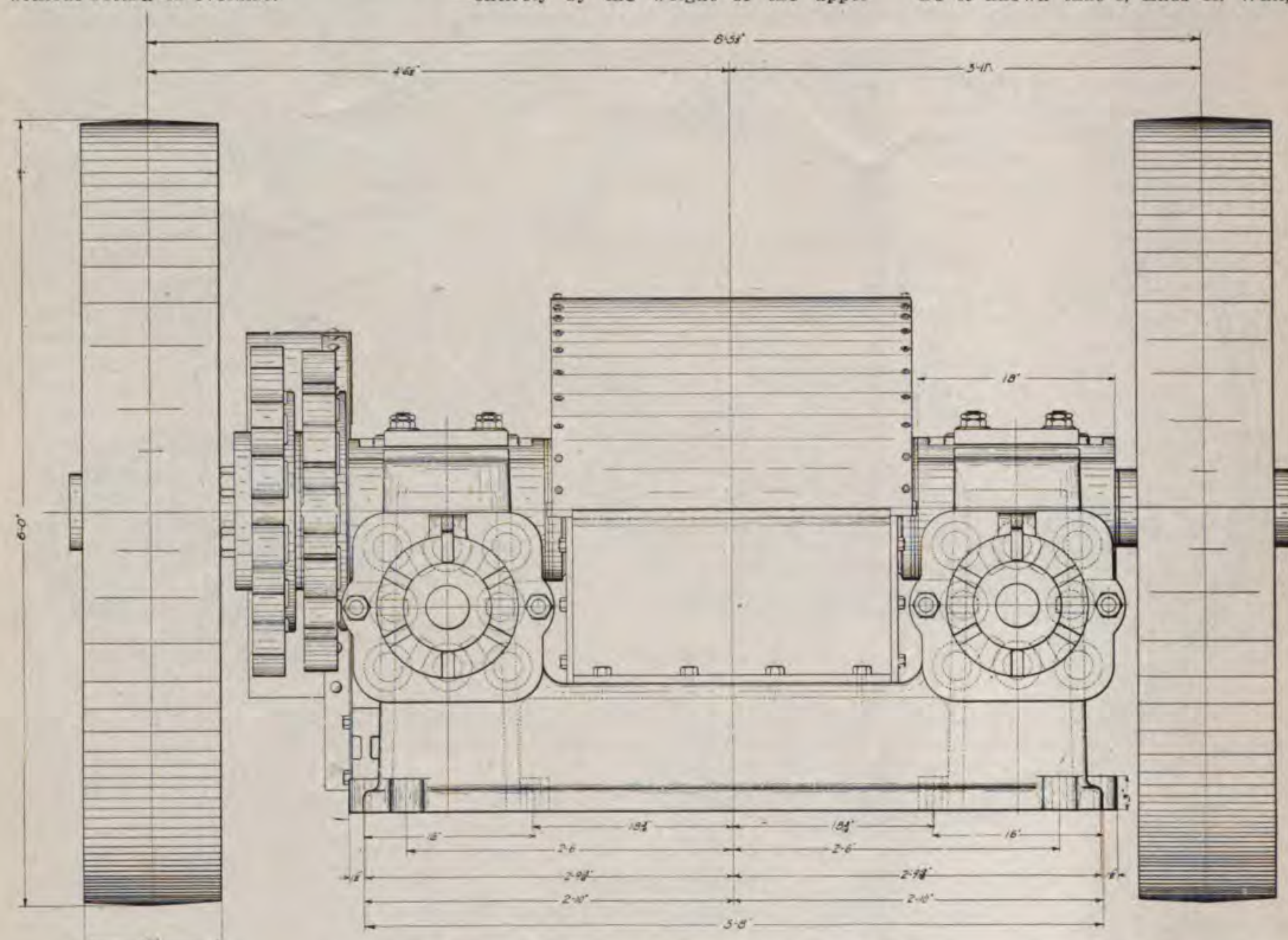
Blake crushers and receiving direct from the bins the run of mine ore and effecting a gradual reduction down to about 12 m.m. in size, the coarser material (in small proportion, however), ranging in size up to eight-inch cubes, the rock being quartzite of average hardness.

The installation of these rolls has been exceedingly slow and tedious owing to the fact that they were placed in a section of the mill already occupied by crushing rolls of the Gates manufacture of the Cornish type, and it was thought to complete the installation of the new machinery by replacing the old a piece at a time without the run of mine ore was delivered to the rolls direct from the bins, thus sending to the rolls rock ranging in sizes up to 8-in. cubes. The proportion of the larger sizes, however—that is, ranging from 4 to 8 inches—would probably not exceed 20% of the entire mass. The remarkable feature of this performance is found in the fact that these larger pieces are produced and passed through the rolls without the slightest jar. The larger pieces, owing to the high pertphial speed of the rolls, are simply hammered into fragments before they reach the nipping or crushing point of the rolls.

To indicate the relative capacity of these rolls as compared with the Gates with effective results. The first four months compares with the work done by the Gates rolls upon the same material, minus all material less than 1 in. which has been previously screened out, leaving to be passed through the rolls—as estimated by Superintendent Kidney—about 450 tons. A test of the power consumed during this work was made which shows that the corrugated rolls required 18 h. p. only, as against 39 h. p. consumed by the Gates rolls. The shells of the Gates rolls which were of rolled steel, and therefore of perhaps 40 to 50% less durability, have been changed several times, the highest estimated pro-

duct during the life of those shells being somewhat less than 20,000 tons.

To sum up, it would appear that the same metal, upon similar work, and delivering a given quantity of finished material, would have a durability of from four to seven times greater if used in the corrugated form, to that of the plain face or Gates type; that the power consumed would be in excess of 2½ to 1 in favor of the corrugated form or crushing faces. Using the corrugated rolls in series of gradual reduction the pulp is readily reduced from ¼ to ⅜ of an inch without return of oversize.



Wall's Improved Corrugated Crushing Rolls—End View.

As we understand it no attempt has been made or will be made to offer these rolls on the market until the installation at the Ohio mill has been completed. We are advised, however, that one set has been installed at the sampling plant of the International Smelting Company at Tooele, Utah, and is giving satisfaction.

In respect to the vertical rolls we are advised that eight pairs—42 inches in diameter by 16-inch face—have been installed in the Ohio mill and at this writing have been in operation a little more than three months, treating from 300 to 400 tons per day of material which had passed a 12 m.m. screen, the entire mass—without any return—being reduced to about 3 m.m. and smaller, the resultant pulp being perfectly granular and entirely free from amorphous slimes. The faces of the rolls continue perfectly true as when started, being free from annular grooves or flanging of the outer rims, suchh as result inevitably from the use of the ordinary type of Cornish rolls in common use.

The crushing is done by the Wall vertical rolls—as indicated in the specifications of the patent quoted herewith —entirely by the weight of the upper roll, no spring pressure being applied. This is made possible by the fact that the feed is distributed upon the lower roll some distance from the point of crushing contact and is carried forward upon the face of the lower roll in a sheet the thickness only of the larger grains. A portion of the rolls are set so as to take the product from this crush with the result that a very large percentgae of the feed is reduced to the ultimate size desired for treatment, namely, about 30-mesh. When the installation of these Wall rolls at the Ohio mill shall have been completed the Chile mills now in use may be retired.

WALL'S PATENTED VERTICAL ROLLS

In presenting a description of the Wall patented vertical rolls we are reproducing the original patent drawings and specifications, in which the inventor seems to have clearly anticipated and set forth in a masterful manner all of the difficulties and deficiencies encountered in the old form of rolls, as so ably set forth by Mr. Payne:

To All Whom It May Concern:

Be it known that I, Enos A. Wall, a citizen of the United States, and a resident of Salt Lake City, in the State of Utah, have invented a certain new and useful Improvements in Ore-Crushing Mills, of which the following is a specification.

My invention relates to that class of ore crushing mills designed to receive ores or rock which has been previously broken into fragments of two inches and smaller in diameter and to reduce the same to the smallest possible size consistent with the production of a perfectly granular pulp, and having this object in view I assume the following conditions

to be self-evident and indispensable—viz., that the crushing surfaces must not "grind" or "slip" upon themselves nor upon the material sought to be crushed and that such crushing can only be effected by direct pressure—such, for instance, as would result from the passing of the wheels of a car moving in a straight line upon a smooth track over pebbles placed upon the rails. The "pulp" resulting from such contact, though infinitely fine, would still maintain granular or angular form. A crushing-mill operating upon this principle will possess the highest degree of durability and require the minimum of propelling power; but it is not economically practicable to reduce particles of the size mentioned—i. e., two-inch cubes—to fine powder at one operation, nor with same form or type of crushing-face, for reasons that are familiar to those skilled in the art. On the contrary, machines should be adapted to crush two-inch cubes to about one inch, one-inch cubes to half-inch, and half-inch to one-fourth inch, which size and smaller may be reduced at one operation sufficiently small to pass through a thirty or forty mesh wire screen or to the smallest size desired for effective concentration, amalgamation, or lixiviation processes. Of all gradations that of "finishing" or fine-crushing is most difficult and the resulting character of the pulp most important. If the granular or crystalline structure of the particles be destroyed, as by abrasion between the sliding or grinding faces of the crushing-mill, they become at once impervious to the percolation of "leaching" solutions and absolutely refractory to all known processes of concentration. All "grinding" or attrition mills in common use produce an excessive proportion of such refractory slimes and are therefore subjected to excessive abrasion of the crushing or grinding faces. The ordinary so-called "Cornish" rolls of the various types are effective to a degree; but as at present arranged, side by side in horizontal plane, the crushing is accomplished by oblique pressure upon the ore particles, which results in the parting or grinding off of a portion of all particles passing between the crushing-faces, and consequent abrasion of the roll-faces into annular grooves, thus rapidly destroying their efficiency. These rolls are secured in place a short distance apart, according to the degree of fineness to which it is desired to reduce the material and are held in position with strong spring-buffers or other yielding devices, which places the entire crushing strain upon the journal-bearings of the rolls, thus involving the application of much unnecessary driving power, while the continued shock resulting from vibration of the [illegible]s makes it necessary to provide ponderous bed-frames and expensive foundations.

My invention is designed as an improvement upon my crushing-rolls patented December 22, 1885, No. 332,987, and upon the various types of so-called "Cornish" rolls in common use; and it consists in part in placing one roll directly above the other and in contact therewith, the purpose being to effect the crushing of the ores or other material by means of the weight of the upper or crushing roll alone and without the intervention of springs or other pressure devices. The upper roll is journaled in bearings held loosely in guides formed of the opposite sides of the main frame, so as to admit of unobstructed up-and-down movement, and the lower roll is journaled stationary in bearings secured to the main frame. My upper or crushing roll having this free up-and-down movement, unobstructed by pressure-springs or other similar devices, will travel upon the lower roll, producing a crushing effect precisely similar to that which would result from rolling in a straight line over a flat smooth surface. It is of the utmost importance, however, in order to obviate any grinding effect that both rolls be made to revolve at the same speed, and to insure this result, in addition to having both rolls belted to revolve at the same speed, I provide light

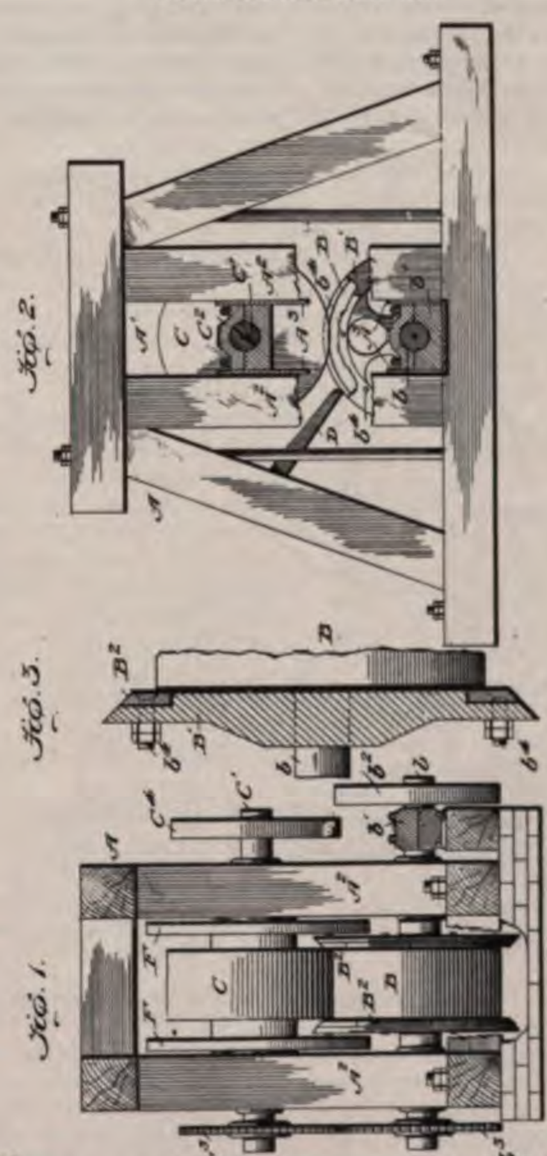
No. 755,725. PATENTED MAR. 29, 1904.

E. A. WALL.

ORE CRUSHING MILL.

APPLICATION FILED FEB. 9, 1903.

NO MODEL.



Witnesses

[illegible]

Albert Popkins

Inventor

Enos A. Wall

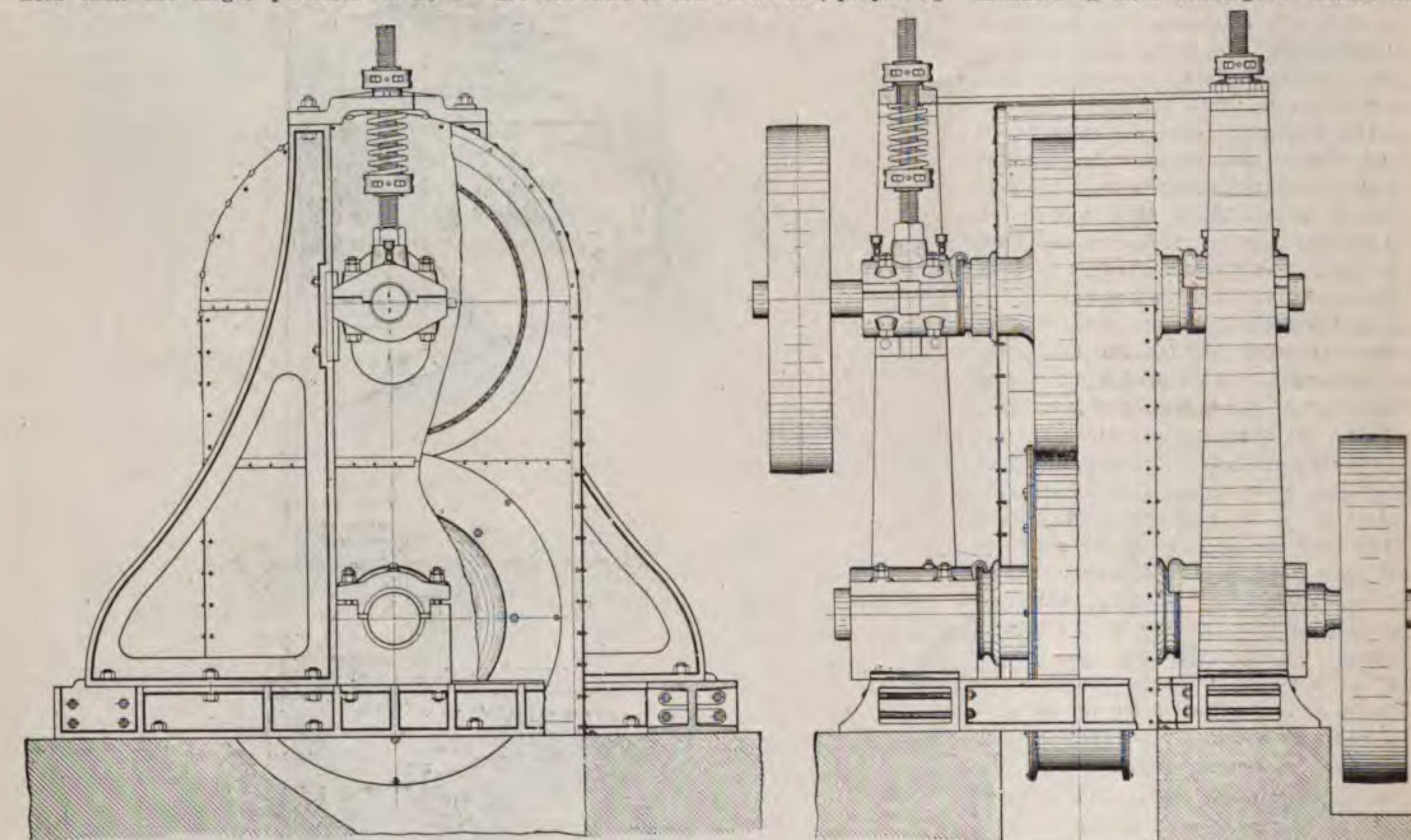
by G. W. McKenna

Attorney

gears, the only office of which is to hold the upper roll back from any tendency to slip upon the lower roll, due to momentum added by the heavy balance-wheels hereinafter referred to and to the inequalities of belt-driving.

To give additional weight and momentum to the crushing-roll, it is provided with two heavy balance wheels. The combined weight of the balance-wheels and the crushing-roll to which they are attached must be sufficient to crush the largest pieces of ore fed to them to the degree of fineness desired. It is evident now that if the feed be introduced in such volume that the sheet of ore spread upon the lower roll be of greater thickness than the larger particles—i. e., if one grain of ore piled upon the top of others—the resulting product will be less finely crushed than if spread out in a sheet of the thickness only of the larger particles, from which it will be seen that the degree of fineness of the pulp may be readily controlled by regulating the volume of feed, which being automatic is in the highest degree simple.

In order that the point of contact or crushing-point between the roll-faces shall at all times be provided with the desired volume of feed, the ore is fed upon the lower roll through a chute of the width of the face of the rolls. This chute must be placed at an incline, upon which the ore particles will readily fall by gravity, the supply being constant and controlled in volume by automatic devices, such as are in common use and not necessary to here illustrate. The ores will then in the fall be spread out in a sheet of the width of the rolls and practically of uniform thickness. This sheet of ore is discharged upon the lower roll as far as practicable away from the point of contact with the upper roll. The material will then be carried to the crushing-point with the peripheral velocity of the rolls and will be crushed by "direct" pressure of the upper roll, the production of all refractory slimes being thereby avoided. In order that the material shall be retained when fed upon the lower roll, "shields" or guard-plates are attached to the lower roll, projecting a few inches beyond the outer rim of the lower roll and overlapping the ends of the upper roll, as provided in my crushing-roll patent before referred to, thus forming a continuous trough into which the ore is fed and by means of which the feed is uniformly spread to the extreme outer rim of the roll-faces, and thus a perfectly even wear is insured. In practice I find that the projecting portions of the shields or guard plates in time wear by contact with small ore particles falling between them and the ends of the upper roll. To overcome this difficulty, I provide the inner faces of the shields with removable plates of hardened metal made in segments and secured to the shields by means of short bolts.



Side and End Views of Wall's Vertical Rolls—From Working Drawings.

I accomplish the above objects by the mechanism shown in the accompanying drawings, in which—

Figure 1 is an end elevation of my crusher. Fig. 2 is a side elevation, partly in section; and Fig. 3 is a detail view of a portion of the lower roll with its shield and wear-plate.

A designates the framework formed, preferably, of timbers or beams bolted firmly together and having vertical guideways A^1 at its opposite sides. These guideways A^1 are formed by the uprights A^2, the adjacent sides of which are provided with metallic linings or wear-plates A^3.

B is the lower roll with it shaft b mounted in fixed bearings b^1 within the lower end of the guideway A^1, and the ends of the shaft extend beyond the sides of the frame, one end of the shaft being provided with a drive pulley or wheel b^2 and the other end having a light steel gear-wheel b^3.

The ends of the roll B are provided with shields B^1 in the form of rings which are of greater diameter than the roll and bolted thereto. In order to compensate for the wear which takes place at the juncture of the shields and ends of the roll, I provide the inner sides of the shields with removable segments B^2, which may be readily removed by first loosening the shields from the roll and then removing the bolts b^4. In order that the segments B^2 may lie flush with

the inner faces of the shields B', the latter are provided in their inner faces with annular recesses or grooves which extend to the peripheries of the shields, and these grooves extend inwardly within the radius of the crushing-roll B, as shown in Fig. 3, so as to fill the angles between the ends of the rolls and inner faces of the shields without spacing the shields away from the ends of the roll.

C is the crushing-roll, having its shaft C' mounted in the vertically-sliding bearings C² within the guideway A' and having a driving-pulley C⁴.

The rolls B C are belted to rotate in opposite directions.

The crushing-roll bears at its lowest portion on the highest portion of the lower roll, and so exerts its full weight on the material, which would not be the case with a crushing-roll arranged out of vertical alignment with the lower roll, for then some of the force of the upper roll would necessarily be taken up by the inclined guideways and much friction would result also in moving the crushing-roller upward and outward. In my mill the whole weight of the crushing-roll is exerted, and as the roll is absolutely unrestricted in its up-and-down movements by springs of any sort the sudden shocks and strains to the frame-work incident to the use of springs is entirely avoided, and so the frame-work may be entirely of wood, save that the wear-plates A² should be of thin plate metal. The cost of heavy cast frame work is therefore done away with.

The weight and momentum of the crushing-roll is increased by two heavy fly-wheels F F, one at either side, and one end of the shaft has a thin steel gear C³, which meshes with the lower gear b³. These gears b³C³ are of the same diameter and serve merely to hold the crushing-roll against slipping upon the lower roll and against moving any faster than the lower roll, and so cause the formation of a perfectly granular pulp, and thereby avoid the production of refractory slimes.

D is the chute of the same width as the face of the roll B and serving to feed the material in a thin even sheet to the rolls, the point of delivery being as shown in Fig. 2, as far from the crushing point as practicable.

The chute may be supplied from any of the well-known automatic feed mechanisms, not necessary to show here, as they are well known and not claimed herein.

The shields will serve to prevent the material from falling beyond the sides of the rolls, as they form a sort of guide-trough.

In crushing ores from sizes of two-inch cubes to half-inch the crushing-surfaces should be corrugated, as provided in my Patent No. 332,978, above referred to, because this form of crushing-face admits of a much smaller mean diameter in order to secure the necessary grip or "bite" upon the material to be crushed; but where a fine product is desired, as in reducing material one-fourth inch in size to "thirty mesh" or smaller, I prefer that the rolls be constructed with plain crushing-faces and of diameter of at least thirty-six inches.

Having thus described my invention, what I claim as new, and desire to secure by Letters Patent, is—

1. The combination with a frame and a lower roll mounted in fixed bearings therein, of an upper driven crushing-roll having free vertical movement toward and from the upper side of the lower roll, to crush the material passing between the rolls, and an independent driving means for rotating the upper roll in an opposite direction to the lower roll and at the same rate of speed.

2. The combination with a frame and a lower roll mounted in fixed bearings therein, and provided with a pulley for belt-driving, of an upper oppositely-driven crushing-roll having free vertical movement toward and from the upper side of the lower roll and provided with an independently-driven pulley of the same size as the pulley of the lower roll.

3. The combination with a frame and a lower belt-driven roll mounted in fixed bearings therein, of the upper crushing-roll free to move vertically, belt driven in the opposite direction and at the same rate of speed as the lower roll, and means for preventing slipping and faster movement of the upper roll due to independent belt drives.

4. The combination with a frame, a lower belt-driven roll mounted in fixed bearings therein, shields at the ends of the roll and removable plates flush with the inner sides of the shields and overlapping the ends of the roll, of an upper-crushing-roll having free vertical movement and belt-driven oppositely to and at the same rate of speed as the lower roll.

5. In combination with the crushing rolls, one roll being placed above the other and journaled in bearings secured in guides in the main frame, so as to admit of free yielding up-and-down movement, the shields or guard-plates at the ends of the lower roll, and over-lapping the ends of the upper roll sufficient to form a trough for the retention of the material to be crushed and to permit its being carried forward upon the surface of the lower roll across the point of crushing contact, and heavy balance-wheels attached to the main shaft of the upper roll at opposite ends of the said roll and within the frame, substantially as and for the purpose herein specified.

6. In combination with the one roll being placed above the other and journaled in bearings secured in guides in the main frame so as to admit of free yielding up-and-down movement said rolls being belt-driven, the shields or guard-plates at the ends of the lower roll and overlapping the ends of the upper roll sufficient to form a trough for the retention of the material to be crushed and to permit its being carried forward upon the surface of the lower roll across the point of crushing contact, the heavy balance-wheels attached to the main shaft of the upper roll, and gear-wheels placed upon the ends of main shafts of the crushing-rolls and engaged in such manner as to control the speed of the upper roll and prevent its slipping upon the face of the lower roll, substantially as and for the purposes herein specified.

7. In a crushing-mill, a roll having end shields of greater diameter than the rolls, and provided on their inner faces with annular recesses extending inwardly within the radius of the roll and segmental wear-plates removably secured in said recesses, flush with the inner faces of the shields.

8. An ore-crusher comprising, a main frame having vertical guideways, a lower belt-driven roll having its bearings fixed, annular shields at the ends of said roll, an upper oppositely belt-driven crushing-roll in the vertical plane of the lower roll and having an unobstructed movement to and from the face of the lower roll, meshing gears of the same size on the shafts of the said rolls to prevent slipping and faster movement of the upper roll due to inequalities of belt-driving, and a feed-chute of the same width as the face of the lower roll and delivering thereon, substantially as and for the purposes herein specified.

In testimony whereof I affix my signature in presence of two witnesses.

ENOS A. WALL.

Witnesses:

WILLARD HANSON,

W. R. SMITH.

Tire punctures may be sealed by the use of a mixture made of 4 oz. of pumice (pulverized), 2 oz. of dextrin, and 10 oz. of water. Force the paste into the tube through the valve, after the insides have been withdrawn, by means of a small metal filler. It is claimed that this paste will close a good-sized hole and enable the machine to proceed for many miles without detaching the tire; in fact, in one case a tire so repaired is said to have remained fully inflated for a week. When the tube is patched care should be used to see that all of the paste is removed from it.

AUTOMATIC LANDING CHAIR

An extremely simple and effective device for the automatic landing of cages and skips has been invented by F. C. Wright of Denver, who has placed the exclusive manufacturing rights to his inventions in the hands of the F. M. Davis Iron Works Co. of Denver.

The striking feature of the landing chair is that it may be left at all times, if desired, ready to receive the cage, but the cage may be landed or not as desired without requiring the attention of a station attendant or cager. When desired, the chair may be locked out of the landing position, but it is impossible to lock it so that the cage cannot pass.

Reference to the accompanying sketch will give a clear understanding of Mr. Wright's device. Letter A shows the chair proper, pivoted freely in the metal frame D. Letter B shows the trip which is normally held in the position shown by full lines by means of a weight C. When the cage descends, the trip B is carried down, striking the dog A and folding the trip and dog back into the frame, which allows the cage to pass freely. When the cage is rising, the dog is pushed back into the frame and the trip is raised to the vertical position as indicated by the dotted lines. To land at any station, the cage deck is droped a few inches below the station to allow the trip B to return to the horizontal position, then the cage is raised a few inches to allow the dog A to fall into the landing position. To lower below the station the cage is raised above the trip B a short distance, then is dropped through to any station below.

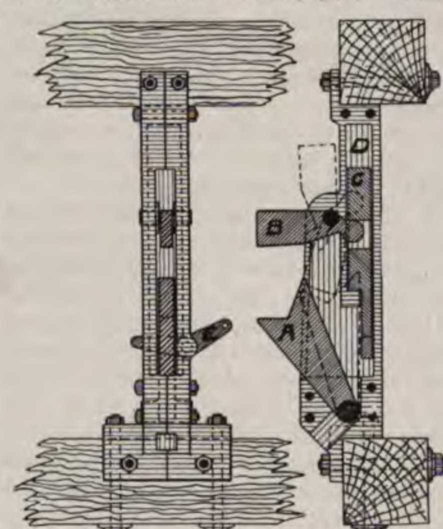
It will be seen that the means of secvuring this result is very simple. The hoisting engineer has only to stop the descending cage at a point just below the chair, then lift it just above the chair drop the cage in place. In the case of the ascending cage, the deck is stopped just above the station and then dropped in place.

Mr. Wright's patents also cover a system of skips for use in vertical shafts, the feature of the system being that the skip may be dumped on either side of the shaft, either on the surface or underground, all as desired by the skip tender.

The skip body is hinged to the lower side of guides of the usual form and is locked to the top of the guides by an automatic latch. The hoisting rope is attached to a bail which is secured to the body.

The dumping is performed by a form of landing chair as described above. A special chair is fixed in the guide timbers, with other chairs on either side at a slightly higher elevation. When the skip is landed for dumping, the guides are held stationary and are automatically unlocked from the body while the bottom of the skip body lands on the side chairs, on one side of the shaft center. By lowering, the engineer causes the skip to dump. The direction of dumping is controlled by the skip tender locking one pair of chairs out of the shaft by means of a bell cord. Waste may be dumped at one side of the shaft and ore at the opposite side. By placing a set of chairs above any worked out stope the waste may be dumped underground on either side of the shaft. The skip passes freely through the underground dumping chairs as in the case of the cage.

The landing and dumping chairs are of heavy forged steel working parts mount-



Wright's Automatic Landing Chair.

ed in a cast frame. They are designed to suit any load and to fit any size guide timbers.

FEW THINGS WORTH KNOWING

The great pyramids of Egypt are built of limestone, and they stand upon a limestone plateau.

****

In order of their money value, coal, gold, manganese, petroleum, salt, saltpetre and mica are the seven principal materials mined in India.

****

A jet of compressed air directed against the heated ends of work that is being forged will revive the heat and also blow off all dirt and scale.

****

The Bunker Hill & Sullivan Mining & Concentrating Co. paid dividend No. 172 of $65,400 on January 4, 1912. This makes the total amount of dividends paid $13,225,050.

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Unless solutions entering zinc boxes are fairly strong in free cyanide, it is advisable to allow strong cyanide solution to drip into the first compartment. Better precipitation is obtained thereby, and the formation of the troublesome "white precipitate" is largely avoided.

****

The metals that do not readily ozidize on exposure to the air are gold and platinum and to a less degree silver, copper aluminum and zinc. Tin resists oxidation, though ordinarily tin plate oxidizes rapidly, as the central part is either iron or steel.

****

To find the thickness of lead pipe required when the head of water is given, multiply the head in feet by the size of pipe wanted, express decimally and divide by 750. The quotient will give the thickness required in hundredths of an inch.

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Experiments show that salt up to 10 per cent does not decrease the ultimate strength of mortar. The amount of salt required to lower the freezing temperature is approximately 1 per cent of the weight of water per degree F. below freezing.

****

The work in foot-pounds done by a pump is the product of the weight in pounds of the liquid pumped and the height in feet through or against which it is lifted. The power is the work done in a unit of time and the horse-power is the work per second in foot-pounds divided by 350.

****

The preservation of iron in concrete is again attested in the demolition of an old gasometer at Hamburg, Germany. This structure was built about 1852 and when taken down the iron anchor bolts which had been completely encased in a cement concrete were found to be as fresh and bright as new iron, with no traces whatever of rust.

****

The Wellhouse method of preserving timber consists in first steaming it in a cylinder for from one to three hours. A solution of zinc chloride and glue is then forced in under pressure, after which tannin is injected. The glue combines with the tannic acid in the wood and is precipitated as an insoluble compound while the wood retains the zinc. An excess of tannic acid is added to precipitate the glue.

****

According to the building laws of the city of New York, reinforced-concrete structures shall be so designed that the stresses in the concrete and steel shall not exceed the following limits. Extreme fibre stress in compression, 650 lb. per sq. in.; in direct compression, 500 lb.; in shearing, when all diagonal tension is resisted by steel, 150 lb., and 40 lb. in shearing when diagonal stresses are not so resisted.

LEACHING APPLIED TO COPPER ORE* (XVI)

TREATING ON THE RECOVERY OF THE SILVER AND GOLD CONTENT OF AN ORE

By W. L. AUSTIN.†

Most copper-ore subjected to metallurgical treatment by wet methods contains variable quantities of the precious metals and the recovery of these becomes important in many cases. The actual quantities of gold and silver in a given ore may be so small as to be neglected in the assay office, yet the aggregate recovered in a year's operations can be considerable. For instance, in the annual report of the Utah Copper Company the income account for the fiscal year ended December 31, 1910, credits operating revenue (milling ore) with 39,837.9 oz. gold, and 381,331.22 oz. silver recovered. On the basis of 4,340,245 tons treated, this would amount to 0.0091 oz. gold, and 0.087 oz. silver, per ton of raw ore, or less than 25 cents—an amount too small to be accurately determined in commercial assaying. These figures refer to the porphyry-ore alone and do not include "sulphide-ore" operations: they indicate to what proportions an apparently insignificant quantity of the precious metals can attain when present in a leaching-ore, and which can be recovered by making use of a competitive process. It is only in exceptional cases that loss of the precious metals in leaching copper-ore can be ignored.

In considering the recovery of the gold and silver content of a copper ore by leaching methods, the question arises as to whether this can be most economically accomplished before the copper is precipitated, or whether it should be saved simultaneously with the copper, or whether recourse should be had to an independent operation subsequent to the copper leaching. The problem has often presented itself, and various methods of solving it have been suggested and carried out, differing according to the lixiviants employed.

CYANIDATION OF RESIDUES.

One way of meeting the difficulty which is often advocated, is cyanidation of the residues from the copper-leaching operations. This method of procedure is, however, open to the objection that inasmuch as acid lixiviants are usually employed, their removal from residues before applying cyanide solutions is very difficult to accomplish, and unless this is done their presence results in heavy consumption of cyanide, and consequently undue expense is incurred in this method of treatment. Furthermore, in the generality of cases the precious metals are present in such small quantities that the employment of a separate process for their recovery—cyanidation for example—is inadmissible, and if they are to be saved at all, this must be accomplished during the copper-leaching process proper.

The method which has met with most favor by advocates of copper-leaching methods, has been chloridization of the gold and silver, and their removal, in the early stages of the leaching operation. Chloridization can be effected either in the dry or wet way, the choice of method depending upon circumstances. When an ore is roasted, (and with most leaching processes a preliminary heat-treatment of the ore before applying the lixiviant will be found desirable), salt (NaCl) may be introduced into the furnace and the chlorides formed by the action of this reagent can be more or less successfully removed in soluble form. The same results have been accomplished by treating roasted ore with powerful chlorine lixiviants without applying salt in the roasting process.

With regard to the method first mentioned (removal of the precious metals prior to the copper), the practice in Europe in treating pyritic ore residues from sulphuric acid works has been to roast them with salt, and then to leach with hydrochloric acid. In the manufacture of sulphuric acid the "burned" pyrites constitute a by-product, valuable for smelting into pig-iron; but before being used for this purpose the copper, silver and gold contained in them are removed by leaching. To obtain satisfactory results it is necessary to observe certain precautions in roasting an ore which it is intended to leach; but this subject will be reserved for a future chapter—its consideration at this time would lead to a wide digression.

The residues from the pyrites burners of the acid works are generally assumed to contain silver in the form of sulphate and gold in the metallic state. By roasting with salt the result is indicated in the following formulae:

$Ag_2SO_4+2NaCl=AgCl+Na_2SO_4$

$Au_2+3Cl_2=2AuCl_3$

These chlorides are assumed to go into solution in a salt lixiviant, in which cases the metals may be thrown down together with the copper, by the use of scrap-iron, as indicated in the following:

$2AgCl+yNaCl+xH_2O + Fe = 2Ag + FeCl_2+yNaCl+xH_2O$

$2AuCl_3+yNaCl+xH_2O + 2Fe = 2Au+ 2FeCl_3+yNaCl+xH_2O$

The precious metals would then have to be separated from the copper in a subsequent refining operation, for even if fractional precipitation is resorted to, the metals will be more or less mixed.

Another way of recovering precious metals from a cupriferous solution is by employing sodium iodide, (Claudet's method), with the addition of sugar of lead, (lead acetate), or tannin, to the solution to assist in clarifying it. The reaction is indicated in the following:

$2AgCl+yNaCl+xH_2O+2NaI = 2AgI+ (y+2)NaCl+xH_2O$

$2AuCl_3+yNaCl+xH_2O + 6NaI = 2AuI +4I+(6+y)NaCl+xH_2O$

These compounds of the precious metals with iodine may then be treated with sulphide of sodium, and in this way sodium iodide is regenerated and the precious metals are thrown down as sulphides:

$2AgI+Na_2S=Ag_2S+2NaI$

$2AuI_3+3Na_2S=Au_2S_3+6NaI.$

Claudet's method appears to have been extensively used at one time. It is referred to in Berg und Huettenmaennische Zeitung 1871 pages 20, 120, 413; 1872 page 150; 1875 page 62; 1881 page 348; 1882 pages 137, 232; 1885 pages 233, 563; 1886 pages 239, 252. Iodide of silver is almost completely insoluble in sodium chloride solutions, and the precipitate separates out in about 48 hours. It consists chiefly of sulphate of lead, (the lead derived from the lead acetate), and the silver salt. It is reduced by metallic zinc whereby the iodine is recovered for further use. As cuprous chloride interferes with the process by producing iodide of copper, all the latter metal must be present in the lixivium as

† Mining Engineer and Metallurgist, Riverside, California.

cupric chloride when the soluble iodide is added. The acetate of lead solution used for clarifying consists of about one-half pound of this salt dissolved in a ton of liquid. The tannin solution is made by dissolving six lb. glue in 100 lb. of water, and mixing with from 300 to 400 lb. tannin solution made by boiling white-oak bark in water. Precipitation of gold and silver by zinc iodide was employed at Oker in Germany: the process was also an integral part of the Longmaid & Claudet process.

The treatment of residues from acid works by the method referred to was used in England near Newcastle and Liverpool, also in Germany at the Duisburg copper works. It has also been in use at Hemixem near Antwerp, and at Natrona in Pennsylvania. Gold was found to go into solution in the leaching and was precipitated together with the iodide of silver. At the Tharsis works near Newcastle the silver recovered contained from one to one-and-a-half per cent gold, while at Widnes it carried about 0.28 per cent.

GERMAN METHODS.

At Duisburg in Germany it was the practice to first give the ore an oxidizing roast, then grind it with NaCl and roast a second time. After proper chloridization it was leached with dilute hydrochloric acid. The precious metals were then first removed by Claudet's method, after which copper was precipitated by means of iron.

At Koenigshuette in Upper Silesia, Rio Tinto pyrites were burned for acid and the residues leached. The roasted ore was given a treatment similar to that employed at Duisburg up to the production of the lixivium, but then the auriferous silver was precipitated by means of metallic copper, and the copper in turn by electrolysis. In 1887 there was produced at Koenigshuette 560.46 metric tons of copper 100% fine; 521.525 kilograms of silver and 0.7527 kilograms of gold. It is interesting to note that the copper slime-precipitate made at these leaching works when examined under the microscope was found to be crystallized. It had the characteristic arborescent crystallization of native copper, and analysis showed that it contained: 80% copper; 18% iron; 2% insoluble residue; and 0.003% silver (30 to 33 grams).

At the Stadtberger works in Westphalia silver is separated from copper by partial (fractional) precipitation of the latter metal. The Stadtberger ore carries chalcocite, malachite, azurite, cuprite, and copper sulphate. It is crushed to about one inch size, and then leached with dilute hydrochloric acid in vats holding 75 metric tons. All the silver is said to go into solution; the assumed reactions between the chalcocite and the copper chlorides are indicated in the following formulae:

$$Ag_2S+CuCl_2+yCuCl_2 + xH_2O = 2CuCl + (y-1)CuCl_2+2AgCl+xH_2O+S$$

$$Ag_2S+2CuCl+yCuCl_2+xH_2O = 4CuCl + (y-2)CuCl_2+2AgCl+xH_2O+S$$

The argentiferous lixivium is treated with scrap-iron in such a manner that only one half of the contained copper is precipitated. The whole of the silver is said to go down with the first half of the copper:

$$4AgCl+yCuCl_2 + xH_2O + (y+2)Fe = 4Ag+yCu+(y+2)FeCl_2+xH_2O$$

The argentiferous cement-copper is washed, refined in a reverberatory furnace, and cast into anodes for electrolytic separation of the two metals.

FRACTIONAL PRECIPITATION.

Fractional precipitation has been made use of elsewhere for the separation of silver, notably at Oker in the Lower Hartz mountains in Germany, where silver was thrown down out of a solution holding the chlorides of that metal and copper by means of sulphuretted hydrogen or sulphide of sodium. In this way the whole of the silver is said to have been carried down with the first six per cent of the copper. Snelus suggested blowing finely divided metallic iron into a chloride solution containing silver and copper whereby the first twenty per cent of the copper precipitated is said to carry down with it eighty per cent of the silver content.

To separate silver from copper when the two metals are precipitated by means of metallic iron from saline solutions, it has been proposed to roast the precipitate and then dissolve out the copper with sulphuric acid. Also to make the material into a paste with water and mixture of salt and soda, and then roast in a reverberatory. The silver chloride could then be removed from the oxidized copper by means of brine. These references to the work of former metallurgists are mainly of historic interest; but they illustrate the fact that the problem is an old one, and sometimes a hint may be obtained which can be turned to account in solving present difficulties.

The old Hunt & Douglas process was another of the leaching methods which aimed to remove silver before precipitating copper. One disadvantage of this process, (leaching copper oxide by means of ferrous chloride dissolved in strong brine) which was introduced at several mines some years ago, was, that silver could only be precipitated from the saline solutions after all the cupric chloride had been reduced to the cuprous salt, because silver chloride in solution is not readily separated from the mixed chlorides of copper by passing over finely divided metallic copper. Furthermore, the Claudet process could not be employed, because, when the solution contained cuprous chloride an insoluble copper iodide was formed. The difficulty may be overcome by digesting the boiling solution with a soluble sulphide until all the copper is thrown down, and then precipitating the silver by other means; but there is nothing to commend this mode of procedure.

The above method was later modified by the patentees in that the ore was roasted so as to form sulphate of copper which was leached out by means of water. Sufficient sodium chloride was added to the solvent to convert the copper present into cuprous chloride, any silver being converted by the cuprous salt into silver chloride and remaining with the gold in the roasted residue. The presence of a large quantity of concentrated brine is necessary to hold the cuprous copper in solution. Then sulphur dioxide was forced through the liquor to change any remaining soluble cupric salt into cuprous chloride. Silver could afterward be removed from the roasted residues by either lixiviation or smelting: gold by chlorination. The advantages of the modified process were that gold and silver did not go into the copper solutions.

To meet difficulties presented by the previous methods a third was devised. In this latter process oxidized copper-ore was attacked with a solution of common salt and ferrous chloride. The resulting clear and neutral lixivium, separated from ferric oxide but containing cupric and cuprous chlorides, was next treated with sulphur dioxide to convert the cupric into cuprous chloride with separation of free acid. From such an acid cuprous solution any silver present can be separated by metallic copper, for it is well known that silver, when present as chloride in sodium chloride solution, may be readily removed by filtering the liquor through a layer of finely divided metallic copper. But metallic copper at once converts cupric into cuprous chloride, so, as a preliminary it is necessary to change the cupric into cuprous chloride by treating the hot solution with sulphur dioxide. Another way of removing the cupric salt is by filtering the solution, near the boiling point, through a layer of coarsely ground matte or rich copper ore.

With reference to the solubility of silver chloride in hot concentrated solutions of the alkali chlorides, or chlorides of ammonia, calcium, zinc, etc., Fresenius states that on sufficient dilution with cold water the dissolved portion separates so completely that the filtrate is not colored by introducing sulphuretted hydrogen. Hahn found that 2.385 grams of silver chloride could be dissolved at 20°C in a litre of solution holding 30.7% ferrous chloride (specific gravity 1.419),

and that 0.836 grams could be dissolved at 30°C in the same quantity of liquor holding 44.48% cupric chloride (specific gravity 1.5726). Further information relative to the solubility of silver chloride in solutions containing other chlorides will be found in Transactions of the Amer. Inst. of Mining Engineers, Vol. X, page 24.

In the Jumau process when precious metals are present, the copper solutions are treated with sulphur dioxide at a raised temperature, but under ordinary pressure. By this means, it is stated, the precious metals alone are precipitated in metallic condition, and are separated antecedent to the copper (Eng. & Mining Journal, July 18th, 1908, page 132). This process, (U. S. patent No. 883,961), was described in Mines and Methods, Vol. II, page 259, and involves leaching an ore with an ammoniacal solution. It was subsequently modified as set forth in U. S. patent No. 930,968.

DEPOSITION OF PRECIOUS METALS SIMULTANEOUSLY WITH COPPER.

With reference to those processes which aim to deposit the precious metals simultaneously with the copper, several may be mentioned. Greenawalt, (U. S. patent 973,776, dated October 25, 1910), recognized the fact that copper ore usually contains variable quantities of other metals, and that these metals must be taken into account in applying a leaching process which is expected to produce commercial results. He comments on the generality of leaching methods requiring one, sometimes two, additional treatments to extract the gold and silver occurring with the copper, and has essayed to remove this objection in the process he advocates.

It has been repeatedly observed that cupric chloride, when warm and in the presence of the chlorides of other metals, acts readily on silver and its compounds in an ore to form silver chloride, thus: $Ag+CuCl_2=AgCl + CuCl$. Greenawalt states that from 80 to 90% of the silver may in this way be extracted with the copper, especially if the ore is given a chloridizing roast. Hence, if an ore contains considerable silver, it may be desirable at times to leach with a fairly concentrated solution of base-metal chlorides in the beginning, to remove as much of this metal as possible.

If there is gold in an ore the content of free chlorine in the lixiviant may be increased, but the solubility of chlorine in water is limited. Chlorine is also only sparingly soluble in a strong solution of chloride of sodium. Such a solution is, however, a fairly good solvent for silver as well as for gold. By the indirect method of combining chlorine with sulphur-dioxide and water, to form acid, any desired strength of acid solution may be obtained for leaching the copper, and at the same time a chlorine solution of sufficient strength for the gold.

The acid chlorine-solution, charged with chlorine, may be prepared either from copper chloride, or from common salt, by electrolysis. It requires 1.7 lb. salt to produce one pound of chlorine, and five pounds chlorine will, ordinarily, extract the gold from a ton of average copper-ore. This chlorine is not lost, for it is ultimately converted into base-metal chlorides in which form it is again used to extract copper and silver from new charges of ore.

Mention is repeatedly made in the foregoing, of leaching with hydrochloric, or other acid solutions. Such active reagents were formerly only available in the vicinity of chemical works, and were unattainable at reasonable cost in remote mining districts. But this has all been changed in modern times by the perfection of electrolytic methods. Nowadays, anywhere that power can be had at reasonable rates, acid reagents in any desired quantity may also be cheaply obtained. This feature has altered the whole aspect of hydrometallurgy of copper, and has done away with many of the difficulties which beset former metallurgists who attempted to work with weak reagents, or such as were at the time very expensive.

When gold and silver occurring in an ore have been brought into solution in the manner indicated above, they may be electrolytically deposited with the copper, or separately if desired, by varying the strength of current. In case the copper is to be subsequently refined, there would, however, be no advantage in separate deposition of the metals.

GREENAWALT PATENT CLAIMS.

In relation to recovery of the precious metals by the Greenawalt process, claim 13 of his patent specifications reads: "A process of extracting copper from its ores containing gold which consists in treating the ore with an acid chlorid solution to dissolve the copper; electrolyzing the resulting copper chlorid solution to deposit the copper and liberate chlorin; bringing the chlorin so liberated, in contact with the solution in the presence of sulphur dioxid; applying chlorin in excess of that combining with the sulphur dioxid, to the solution, to dissolve the gold; returning the regenerated acid chlorid chlorin solution to the ore, and repeating the cycle, as before, until the copper and gold in the ore are sufficiently extracted."

Claim 14 reads: "A process of extracting copper from its ores containing gold which consists in treating the ore with an acid chlorid solution to dissolve the copper; electrolyzing the resulting copper chlorid solution to deposit the copper and liberate chlorin; bringing the chlorin so liberated, in contact with the solution in the presence of sulphur dioxid; subdividing the solution; applying chlorin to the solution in excess of that combining with the sulphur dioxid to dissolve the gold; returning the regenerated acid solution, containing an excess of chlorin to the ore, and repeating the cycle, as before, until the copper and gold in the ore are sufficiently extracted."

Claim 26. "A process of extracting copper from its ores containing other metals which consists in treating the ore with an acid chlorid solution to dissolve the copper and silver chlorid; applying sulphur dioxid to the solution to convert the cupric chlorid into the cuprous chlorid; electrolyzing the cuprous chlorid solution to deposit the copper; electrolyzing salt to generate chlorin and caustic soda; adding the chlorin to the solution to dissolve the gold and other metals contained in the ore; and from time to time adding the caustic soda to the solution to purify it by precipitating out the base elements and regenerating salt."

APPLICATION OF SO_2 TO COPPER LEACHING.

As to the application of sulphur-dioxide, derived from roasting ore, to a bath containing copper chlorides, with the view of producing free acid, it will be recalled that this has been repeatedly done by metallurgists. The plan was an integral part of the new Hunt & Douglas process, and was described by the patentees in 1887. In fact the amount of work done in the field of hydrometallurgy has been so extensive that it would be difficult to suggest a new idea, or combination of ideas, which has not already been applied in practice, or mentioned in the literature of the subject.

The Mosher-Ludlow process, (U. S. patent No. 911,254), is another case where the precious metals are extracted simultaneously with the copper. Here the lixiviant used is a solution containing ammonia. It is briefly described in Mines and Methods, Vol II, page 259, and there is a more detailed article in "Electrochemical and Metallurgical Industry" of March, 1908, from which the following extract is made: "Where the percentage of copper is large the aim is to first extract as much of the copper as is possible by plain ammonia, and to leave the gold and silver values to be subsequently extracted with a weaker ammonia solution containing fractional percentages of potassium cyanide. But instead of working in this way it may be preferable in many instances to add the cyanide at once to the ammonia and to simultaneously extract all the values, including copper, gold and silver, with an ammon-

iacal solution containing one to several pounds of cyanide per ton. The object aimed at is to reduce the consumption of cyanide to a minimum in the presence of copper, by substituting ammonia as the solvent for the copper, thereby permitting the minute amounts of potassium cyanide added to the ammonia solution to simultaneously extract gold and silver values. To recover the metallic values from the ammonia cyanide-copper-gold and silver-bearing solution, it is passed through the continuous boiling-out still, to precipitate the copper as CuO. The boiled-out solution holding the gold and silver values is agitated with the least amount of zinc dust, or passed through zinc boxes to recover such gold and silver as the boiled-out solution may contain."

DEPOSITION OF PRECIOUS METALS SUBSEQUENT TO COPPER.

Coming now to the third case, the extraction of the precious metals subsequent to the copper, the applicability of an additional treatment for their recovery will, of course, depend on the quantity of these metals present in a given ore. In the Froelich method, (Mines and Methods, Vol II, page 68), the precious metals are left partly in the almost wholly decoppered residue; partly go into the lixivium. In the residue they will be respectively in the forms of metallic gold and insoluble AgCl; in the lixivium there will be some AgCl dissolved in the base-metal chlorides, and perhaps some gold chloride. Froelich's method is a treatment of roasted ore in an agitator with hot concentrated ferric chloride lixiviant, with especial emphasis laid on the use of a special form of agitation. By such treatment much of the silver will naturally remain in the residues, for it has long been known that when argentiferous ore is boiled with ferric chloride, silver, after a time, goes into solution, but is apparently reprecipitated, probably by the ferrous salt.

It is suggested by Froelich that the recovery of the precious metals from the residues may be effected through leaching with cyanide of potassium, or ammonia, in an agitator; but that is not a desirable method of procedure, for reasons already given. Recovery of that portion of the gold and silver present in the lixivium, he adds, may be accomplished by passing a weak electric current through the liquor for about three hours. In electrolysis it is well known that gold and silver separate out of the electrolyte when using a low potential more readily than is the case with copper. When the precious metals are deposited with the copper they may be recovered in the anode-mud by a subsequent electrolytic refining in the usual manner.

With this method of treatment it would appear that the precious metals must be to a large extent lost, unless present in an ore in such quantity as to warrant separate extraction by some subsidiary method applicable to the case. The same may be said with reference to leaching with ferric sulphate by the Siemens & Halske process, for when silver is present in an ore undergoing treatment by that method, it had to be extracted subsequently to the copper in a separate operation, or left in the tailings. In some experiments made by Jones, (Proceedings of the Colorado Scientific Society, Vol VI, page 46), wherein he attacked finely divided metals with solutions of ferric sulphate, it was found that silver, copper, antimony and bismuth were readily dissolved, which was not the case when dilute sulphuric acid was used. Gold precipitated by aluminum from a solution of the chloride, when boiled for about ten minutes with a strong ferric sulphate solution was apparently not attacked, a result which has been confirmed by others. In further experiments where ferric chloride was substituted for ferric sulphate, lead dissolved readily, as did copper, bismuth and antimony. Mercury became dirty grey, as though mercurous chloride were forming, which was thought to be probable. Gold did not dissolve, and after boiling for ten minutes only a trace of ferrous iron could be detected in the solution in which it was treated. In an experiment recorded by H. N. Stokes, (Economic Geology, Vol I, page 650), gold leaf when heated in a solution containing two parts ferric chloride to one part hydrocloric acid, went completely into solution, and was subsequently reduced again to metal at a lower temperature by the ferrous chloride formed.

BRADLEY'S TREATMENT OF THE PRECIOUS METAL QUESTION.

In the Bradley process the patent specifications have very little to say about recovery of gold and silver. In this process calcium chloride is the lixiviant used, and it will be remembered that in the Hunt & Douglas process it was found that calcium salts might be introduced into the process, but their presence was objectionable when silver was to be extracted. In the Bradley patent specifications the following references are made to extraction of the precious metals: "There will also be small quantities of gold and silver present in the ore which can be brought into solution by making all the copper into cupric chlorid and all the soluble iron into ferric salts, and then adding a small amount chlorin, chlorous or chloric compounds. The chlorids of silver and gold being soluble in calcium chlorid solutions, may be precipitated with the copper or separately. * * * Any gold and silver present in the solutions may be carried down during the precipitation of the iron, aluminum and copper and subsequently removed or separated therefrom, in any preferred manner known to those skilled in the art."

In the case of a process which depends upon conversion of copper into sulphate by roasting, and subsequent lixiviation of the metal as sulphate, the gold will, of course, remain in the residues. The amount of silver which will be found distributed between the residues and the lixivium, will depend upon the manner in which the roasting has been carried out. An ore can be roasted so that nearly all the silver is brought into the sulphate form, and then this metal can be leached as sulphate, (the old Ziervogel process); but it is a delicate operation, and leaves the copper behind as oxide. In roasting an ore for lixiviation of copper sulphate, probably most of the silver and gold will be found in the residues. This would be the case in applying the Laszczynski process.

Much more might be written about attempts of different hydrometallurgists to meet the precious metal question in connection with copper leaching; but sufficient has been said to indicate that, except in special cases, it is best to remove all the valuable content of an ore which can be brought into solution in one leaching, and to avoid subsidiary operations where possible.

A new artificial abrasive, known as corubin is produced from the slag resulting from the reaction between aluminum and chromium oxides. It is practically pure alumina, containing a trace of chromium oxide, which gives it a red color. On account of the high temperature at which it is manufactured it is free from combined moisture. It is produced in three grades; coarse, medium and fine, and is sold only in the portion of two parts coarse to one each of medium and fine.

A new explosive is reported to have been invented by B. F. B. Wright, former professor of chemistry at Harvard university. The new explosive is said to be almost as safe as dynamite and about three times as powerful. It is said that it will not damage anything unless exploded in an air-tight chamber. The new explosive will stand 275 degrees of heat without igniting, so the danger of spontaneous combustion is obviated. It will not freeze and can be used 15 minutes after being compounded. Dynamite must be stored 90 days before it can be used.

MAMMOTH COPPER SMELTER MEETS FARMERS' DEMANDS

By AL H. MARTIN.

The mines and smelter of the Mammoth Copper Company are located near Kennett, Cal., a town located on the main line of the Southern Pacific railway. The company commenced the erection of the plant in 1905, a short time after the Mountain Copper Company had demonstrated the feasibility of treating Shasta county copper ores by pyritic smelting. In 1906 the smelter went into action, and has been kept in practically continuous operation since. The plant is regarded as one of the best examples of pyritic smelting practice in the world, and numerous improvements made from time to time have steadily increased its efficiency. Not only has the Mammoth Copper Company maintained constant activity since the inauguration of work, but it has successfully defeated all efforts of the farmers to close the plant because of alleged fume annoyance. The smelter is the largest active plant in California, and the company produces approximately three fourths of California's total annual copper output.

MINING AND TRAM SYSTEMS.

The Mammoth ores carry sulphide in the form of massive pyrites, with considerable chalcopyrite occurring. The ores carry about 4 to 5% zinc, while gold and silver values frequently range from $1.10 to $1.50 per ton, sometimes higher. The ore is mined through adits and cross-drifts, the topography of the country and strike of veins favoring economical mining. The orebodies have been comprehensively explored by diamond drilling, and an enormous reserve demonstrated. As the ore is broken in the mine it is loaded into mine cars and hauled by electric locomotives. These are supplied with a direct current at 550 volts. The locomotives haul the cars to the upper terminal of the gravity tram system, where the cars discharge into the bins.

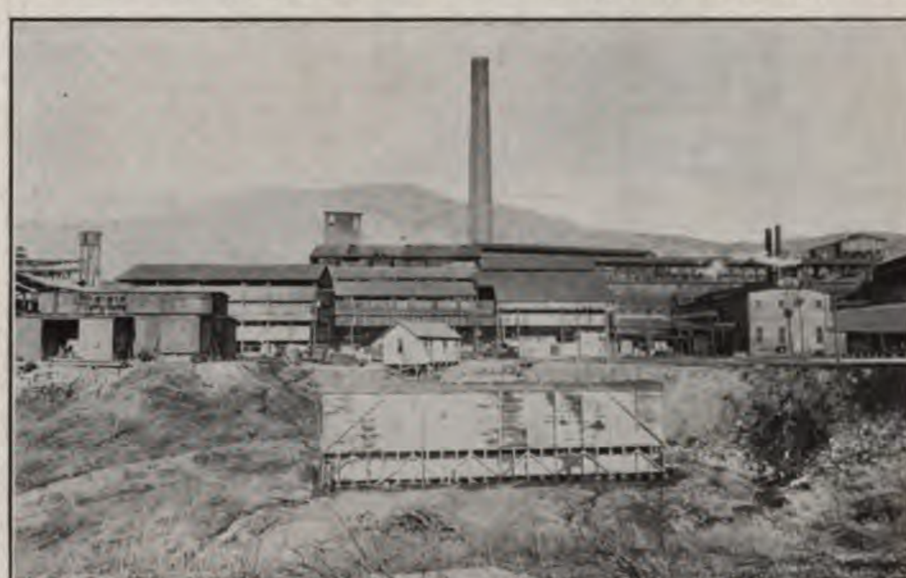
In the tram system, steam, gravity and electricity are employed, the method being influenced by the varying demands imposed by natural conditions. The mine is located 2300 ft. above the smelter, and the gravity portion of the system includes a 4000-ft. mountain slope with a 1700-ft. fall. The tremendous surplus of energy developed by the gravity railroad is utilized to operate a compressor. The bins at the lower portion of the tramway discharge directly into standard-guage railroad cars. The ore received from these cars is crushed, sampled automatically and distributed to three groups of receiving bins. These bins are so arranged that the ore is fed to cars running on tracks below, on the same level as the furnace charging floor.

OPERATION OF MATTING PLANT.

The ore and flux from the bins are drawn off into side-dumping cars, after being properly proportioned. An electric locomotive draws the cars to the blast furnace, and the charge is mechanically delivered directly to the furnace, the feeders commanding each side of the furnace alternately. Each furnace takes a charge of 425 tons. Of this about 326 tons consists of sulphide, with the remainder composed of siliceous ore, limestone, furnace by-products and coke. About 4% of coke is used, experience proving this amount the best for greatest commercial profit. At times the company has found it possible to operate the furnace with 1% of coke, but results were not as satisfactory as when a higher ratio was employed. The furnaces are provided with steel water jacketed hoods, and have a dimension of 50 by 180 ins. at the tuyeres. The plant comprises five matting furnaces, but at present only three are operated. Seven cycloidal blowers, each operated by a 225-hp. motor, deliver the unheated blast at a pressure of 2 5-8 lbs. The blowers deliver 13,764 cu. ft. of air per minute at 111 revolutions. The matte flows into 16-ft. steel settlers, which are tapped by cast-steel ladles. The product is gathered by a 50-ton electric crane, driven by a 75-hp. motor, and delivered to the converter department. The slag passes into 5-ton cars which are hauled to the dumping ground by an electric locomotive.

CONVERTER EQUIPMENT.

The converter building is equipped with two hydraulically-operated stands, eight 96 by 150-in. shells, two 50-ton electric cranes, two pneumatic tamping machines, auxiliary hoists and other machinery. A pressure cylinder, with 18-in. diameter, turns each shell half-around with a 7-ft. stroke. The shells are so arranged that each is permitted to make a complete revolution. A 12-600-cu. ft. Nordberg blowing engine delivers the blast at a 13-lb. pressure. The blower is operated by a 750-hp. electric motor, and the air delivery is regulated by the action of the inlet valve in the air cylinder, according to the amount consumed by the converters. The shells and stands are of the Allis-Chalmers type. Two 50-ton electric cranes, actuated by 75-hp. motors, serve the converters. The cranes have 50-ft. spans, and each are provided with two 15-ton auxiliary hoists. The copper is directly cast by the converters into iron molds, cooled and shipped to Chrome, N. J., for refining.



General View of Mammoth Smelter, Kennett, Calif.

The lining for the converter shells consists of crushed quartz and clay and is thoroughly prepared in two 7-ft. mortar mills. The material is placed in position with the aid of two pneumatic tamping machines, reinforced by a hydraulic jib crane, secured to one of the steel columns of the building. The tamping machine is fashioned on the principle of the rock drill, with a heavy cast-iron jacket to absorb vibrations. Oil burners are employed to dry the lining. One shift in the lining room supplies material for three blowing shifts.

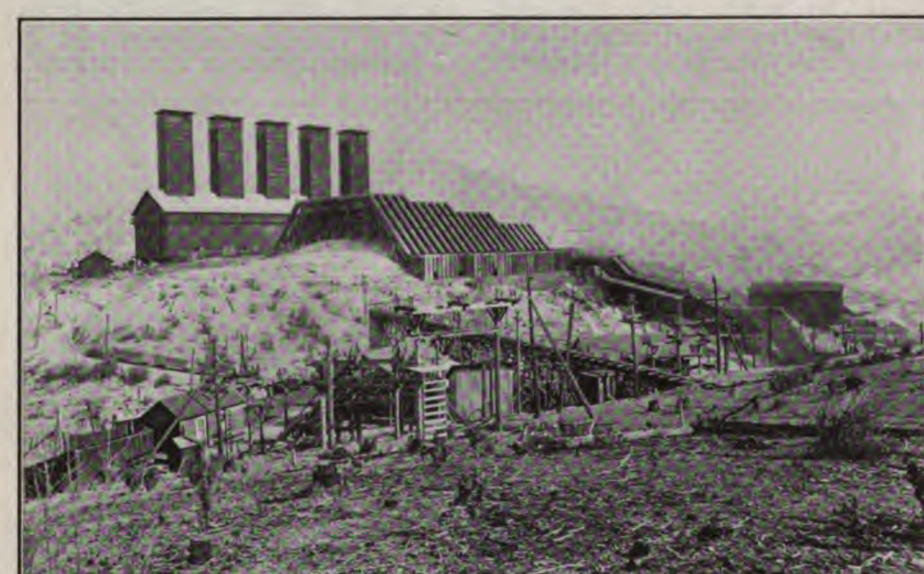
ONLY PLANT OPERATING ON SHASTA COPPER BELT.

The Mammoth enjoys the distinction of being the only active smelter on the Shasta copper belt. This result has been achieved by the adoption of demonstrated effective methods for the control of noxious fumes, rather than by costly experiments with methods of unproven merit. As the gases leave the steel gooseneck downtakes of the blast furnaces they pass into two brick flues 260 ft. long. The converter gases join the fumes from the blast furnaces near the point of entry. The dust settles through the hopper bottoms of the flues into a brick and steel settling chamber. Four 8-ft. steel pipes guide the gas into a second steel collecting chamber terminating in a steel flue having a diameter of 15 ft. This continues into a second building where two Sirrocco fans, driven by two 400-hp. motors, are installed. The fans force the gas through another steel collecting chamber and into the eight banks of cooling pipes. Each bank or compartment contains five pipes, each 200 ft. long and arranged in rising, horizontal and downslanting sections. These pipes discharge into a steel distributing chamber where the gas temperature is further reduced by the admission of atmospheric air. From this chamber the fumes are forced through short pipes into the baghouse.

BAG HOUSE AND GAS COOLING.

The baghouse contains approximately 3000 woolen bags, 34 ft. long by 18 in. wide. The bags are shaken into rows of hoppers located directly beneath by a mechanical shaking device. The fumes are collected and a portion mixed with the settlements in the pipes and sent to the briquetting plant. The remainder is sent to a storage pile to await the devising of a method for the recovery of the zinc content. The present equipment of bags and cooling pipes permits the operation of three furnaces in cool weather, and a ninth compartment of cooling pipes will soon be installed to facilitate a maintenance of present capacity in the hot summer months. The prime duty of the cooling-pipe equipment is to reduce the temperature of the gases to such a point that the fumes will not burn the costly woolen bags.

The three active furnaces deposit about 25 tons of material per day in the baghouse. This consists principally of zinc oxide and sulphate, with considerable silver and some gold. The 4 to 5% of zinc carried by Mammoth ores forms oxides in the furnaces and neutralizes the harmful properties of the noxious gases. A device has been provided for the admixture of reagents with the gas to prevent injury to the bags by sulphuric acid and other chemicals, but thus far its employment has not been necessitated.



Baghouse and Banks of Cooling Pipes, Mammoth Smelter.

FUME CONTROL IS A SUCCESS.

The baghouse has been in commission nearly two years, and has given complete satisfaction in every respect. The efficiency of this annex is apparent when it is stated that the Balaklala, Bully Hill and other large smelters are idle as a result of the smoke agitation. The Balaklala attempted to solve the question with a costly installation of the Cottrell process, but results were far from satisfactory and the big plant has since lain idle. The Mammoth was about the first company to undertake the subjection of the fumes, and its signal success indicates what may be done by other companies in this respect.

A peculiar aspect of the fume-control question at Kennett, is that the atmospheric conditions have always favored the Mammoth people. Cross-currents of air drive the smoke up Backbone and Squaw creeks, where practically little value in the way of agriculture or timber exists. This feature assisted the company prior to the installation of the baghouse, and has probably had the result of increasing the efficiency of the annex to a slight extent. The gardens, orchards and farms around Kennett compare favorably with any found elsewhere in the fertile Sacramento valley, and this condition is particularly striking since the baghouse and cooling pipes went into commission.

WORKS TREAT CUSTOM ORE ALSO.

In addition to treating its own ore, the Mammoth Copper Company handles large quantities of custom material, receiving shipments from numerous points in California and Nevada. The company is a subsidiary of the United States Smelting, Refining & Mining Company, and much of the Mammoth's success in solving the fume question is probably due to the experience gained by the parent company at Midvale, Utah.

Since the installation of the baghouse the two giant smokestacks formerly employed have been dispensed with, and one has been lowered. The other will probably be dismantled soon. Thus every particle of smoke is forced to pass through the cooling tubes and bags. Splendid facilities have been provided for repair and maintenance work, and the plant is practically self-sustaining. An abundant water supply is derived from a mountain stream, with the Sacramento river made accessible, should occasion compel, by means of two centrifugal pumps. The ditch and flume line is over three miles long. G. W. Metcalfe is general manager; J. H. Kervin, smelter superintendent.

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White lead is composed of a combination of lead carbonate and lead hydrate, it is supplied to the trade ground in linseed oil.

HISTORY AND GEOLOGY OF SITKA MINING DISTRICT

By ADOLPH KNOPF*

The first attempts at lode mining in Alaska under the American regime were undertaken in the vicinity of Sitka in 1871. This work was done on a quartz ledge outcropping at the falls of Indian River, 1 mile east of Sitka. Although no serious efforts were put forth, the matter aroused some local excitement, and news of the discovery appeared even in San Francisco newspapers. In 1872 three placer miners discovered near the head of Silver Bay the quartz ledge subsequently known as the Lower ledge, but it was considered valueless by them. Some of the ore was seen by Nicholas Hayley, who had previously worked in the mines at Grass Valley, Cal., and the Comstock, and who was then serving in the garrison stationed at Sitka, and the lode was located by him. Late in the same year he discovered the Stewart ledge, which was named after Maj. Joseph Stewart, United States Army. Before 1880 many other ledges had been discovered in the district around Silver Bay. In 1879 a 10-stamp mill was erected on the Stewart property.

Petroff†, writing in 1880, says:

"Discoveries of gold-bearing quartz have been made on Baranof Island, in the immediate vicinity of Sitka, only since the transfer of the Territory, and for a time quite an excitement was created; but now these ledges are scarcely worked at all, being simply held by the owners for further developments or until some process can be discovered for working with profit the peculiar grade of ore existing there."

In the winter of 1880-81 a considerable part of the population of Sitka participated in the stampede that led to the founding of Juneau. After the lapse of nearly 40 years since the original discovery of gold-bearing quartz, none of the properties at Silver Bay have been put on a productive basis. During that time some remarkable mining failures have taken place on Baranof Island, those at Rodman Bay and Pande Basin being well known throughout southeastern Alaska. This state of affairs led to the nearly complete extinction of all interest in lode mining in the Sitka district, and it is only since the discovery of gold ore at Klag Bay on Chichagof Island in 1905 that interest has in some measure revived.

The Sitka mining district comprises Chichagof, Baranof, and Kruzof Islands, together with a few smaller islands. The total land area roughly approximates 4,500 square miles, the greater portion of which is included in Chicagof and Baranof Islands. Those two islands form in effect a single land mass, gradually tapering southeastward, separated into two parts only by a narrow body of water known as Peril Strait. Its extreme length from Point Adolphus on the north to Cape Ommaney on the south is 150 miles, and the average width is 30 miles. On the east the islands are separated from the other islands of the Alexander Archipelago by Chatham Strait, on the north they are separated from the mainland by Icy Strait, and on the west they are bordered by the Pacific Ocean.

The topographic features of the islands are entirely similar to those of the remainder of southeastern Alaska. The coast line is indented by numerous bays and fiords, many of which, like Tenakee Inlet and Whale Bay, penetrate far inland into the heart of the islands and render territory accessible that is otherwise nearly impenetrable. The relief is rugged and the mountains rise abruptly from the shore, at many places forming bold cliffs, hundreds of feet high, surmounted by precipitous slopes, rising 2,000 to 3,000 feet. The ruggedness increases toward the interior of the islands and little is yet known concerning the inland portion of this region. In general, the altitudes range from 2,000 to 4,000 feet.

The region is well forested with coniferous species, mainly hemlock, spruce, and cedar, both red and yellow. Jack pine is found in small amount and is limited to open, boggy parks, being apparently unable to compete in the more favorable situations with the other conifers.

On the west coast, as at Klag Bay, the timber line reaches 1,500 feet above sea level, but in protected localities it reached 2,500 feet. The diameter and height of the trees vary considerably from place to place; at Klag Bay, for example, 18 inches appears to be the average diameter, whereas along Indian River, east of Sitka, magnificent trees are common, spruces as much as 6 feet in diameter and 175 feet in height having been noted. As a rule, the supply of timber is adequate for general mining purposes, but the stand of logging timber is comparatively small and is soon exhausted at any one locality.

A thick and luxuriant undergrowth is common in the forest and consists largely of blueberry brush and devil's club, with various other kinds of growth, such as willow, alder, salmon berry, and the high bush cranberry. On account of the frequent rainfall this undergrowth is almost continuously wet, and this feature, together with its jungle-like character and the numerous windfalls of timber, make the forest a formidable obstruction to the prospector.

The geographic and climatic features, as well as the forest, impose limitations on the prospector's activities. As the waterways furnish the only means of communication with the centers of supply, which are few and widely separated, a boat, preferably a power boat, becomes a necessary part of the prospector's equipment. The waters are often rough and stormy, the islands are exposed to the open ocean, and in winter the heads of the bays are frozen up—all conditions that tend to restrict prospecting to the summer months. In order to utilize the few favorable months of the year as effectively as possible, prospecting has hitherto been confined mainly to examination of the shore-line exposure and to the country closely bordering the coast.

The climate of the region is cool-temperate and humid. The precipitation is heavy, the number of rainy days is large, and foggy and cloudy weather is of frequent occurrence.

Records have been kept for a longer period at Sitka than at any other Alaska station, so that unusually full statistics concerning the climatic features are available. The mean annual temperature at Sitka is 44° F. The mean monthly temperature for February, the coldest month, is 33°, and for August, the warmest month, 56°, the mean annual range being thus only 23°.

The average annual precipitation, including melted snow, is 88 ins., and the extremes on record since 1868 are 59 and 140 ins. The average number of days during which precipitation takes place is 208. At sea level the precipitation is usually in the form of rain, but there is a considerable snowfall on the mountains, which, even at moderate altitudes, often remains until late in summer.

The present-day glaciation is represented, so far as is now known, by a few small glaciers only, but doubtless a number of others will be discovered when the interior of the islands becomes better known. At Pande Basin, east of Sitka, a glacier occupies the hanging valley at the head of the basin; and another smaller glacier, known as Valdenar Glacier, lies at the head of Green Lake Valley, east of Silver Bay.

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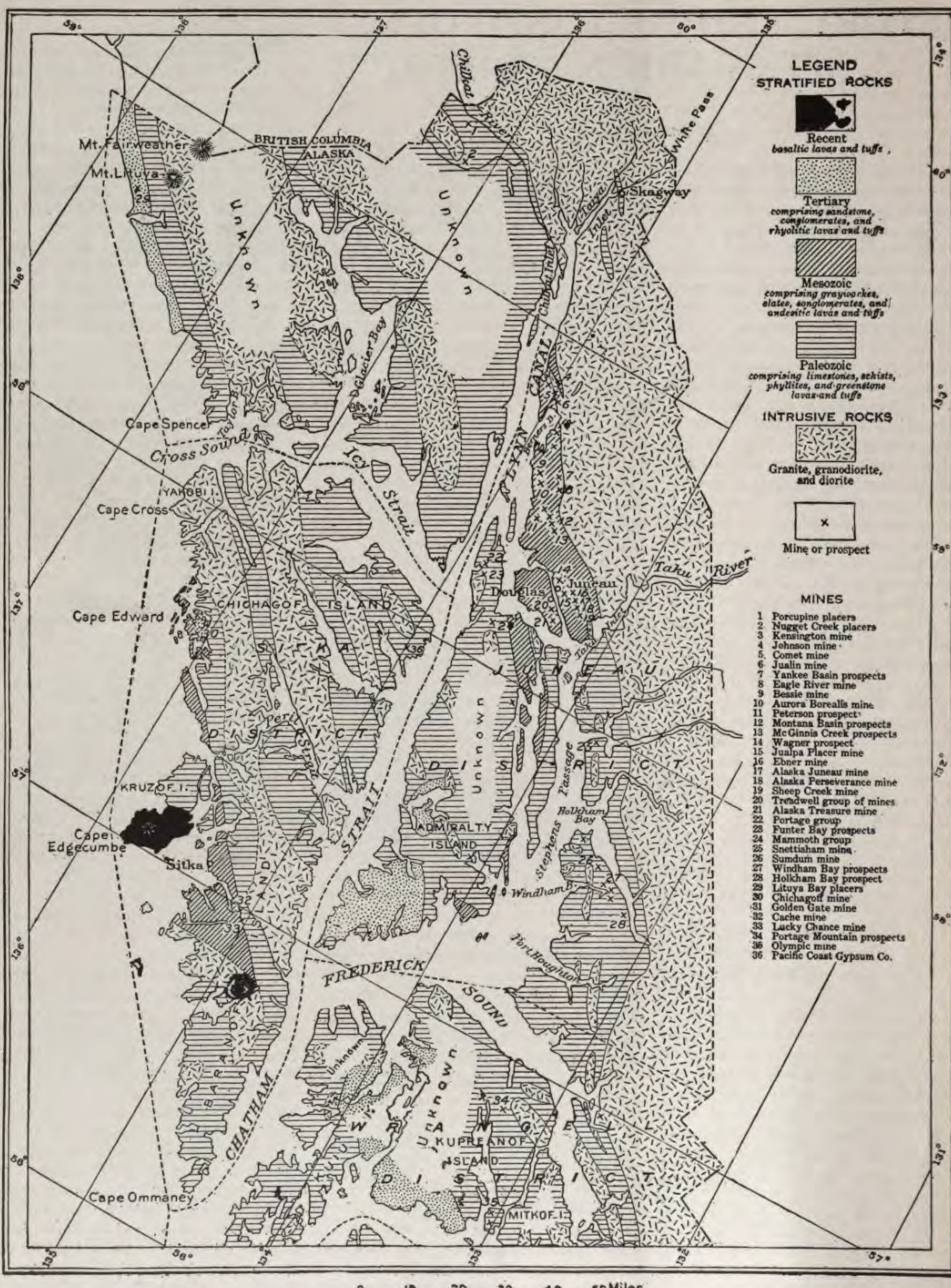
*Extract from Bulletin No. 504, United States Geological Survey, 1912.

†Tenth Census, Vol. 8, Report on the Population, Industries and Resources of Alaska, p. 20.



Geologic Reconnaisance Map of Sitka and Juneau Mining Districts.

Evidence of a former greatly extended glaciation, of which the present glaciation is the vanishing remnant, is everywhere visible. The deeply fiorded character of many of the waterways is the most immediate token of the former glacial occupancy of the region, and this evidence is corroborated everywhere by smaller and more local features due to glacial action. These consist of polished and striated surfaces and of glacial drift several feet thick containing striated boulders.

At Klag Bay broad, glacially smoothed surfaces were found up to an altitude of 1,200 feet on the flank of Doolth Mountain, an isolated mountain which is too small to have supported an independent glaciation. The smooth, flattish summit, reaching an altitude 2,100 feet above sea level, may itself owe its form to the action of an overriding ice sheet, for the neighboring mountains that attain higher altitudes show serrate profiles. As Doolth mountain practically stands on the shore of the Pacific ocean, these figures furnish a rough estimate of the minimum thickness of the ice sheet as it reached the open ocean during the glacial epoch.

GENERAL GEOLOGY.

The rocks of Chichagof and Baranof islands lie in broad belts that strike northwest and southeast, conforming with the prevailing structural trend of southeastern Alaska. The core of the islands is made up largely of granitoid rocks, mainly quartz diorites, which, as a rule, have been intruded parallel to the stratified rocks. The general distribution of the rocks is shown on the sketch map accompanying this article.

The known mineral resources of the Sitka mining district are gold and gypsum. To these granite may, perhaps, be added as a possible undeveloped resoruce.

The gold is found in quartz lodes, which commonly occupy shear zones in graywacke. Two properties, both situated at Klag Bay, on the coast of Chichagof Island, have so far been put on a productive basis and give strong promise of a prosperous career. The ores, which range in value from $15 to $30 a ton, are of considerably higher grade than the average ore of southeastern Alaska. A large number of ore bodies of the same general character have long been known to occur near Sitka, but owing to the low-grade ores contained in them none have yet been brought to a producing stage.

The ore bodies of the region show neither in their mode of occurrence or origin any obvious or immediate relation to contacts of dissimilar rocks, to dikes, or to other igneous rocks. The principal mineral belt appears to lie along the edge of the slate-graywackle formation bordering the band of metamorphic rocks that flank the diorite occurring in the central portion of the islands. The better known ore deposits are found in graywackle, but this is doubtless a fact of no essential significance and should not deter the prospector from searching in other kinds of rocks. The question is sometimes asked by the prospector whether the formation at some particular locality is favorable. To this it can be answered that experience has shown that no one kind of rocks is more likely to contain gold-ore deposits than another. In point of fact, a more complex set of conditions is necessary than the presence of a "favorable formation." That a favorable set of conditions is most likely to be found in the zones that border the long belts of granitic rocks traversing the region has already been maintained in this report. The indications afforded by present developments point strongly to the conclusion that the entire strip of territory contiguous to the west coast of Chichagof Island offers a more encouraging inducement to the search for new ore bodies than any other part of the region.

LOUISIANA SALT MINES

By PAUL WOOTON*

Since 1790 Louisiana has been a producer of salt. In the early days the supply was obtained from brackish springs that spouted vigorously from the ground over the great deposits of rock salt, that later were pierced by shafts, and today are mined in enormous quantities with the aid of modern machinery. During the war of 1812, when the salt supply from Liverpool was cut off, the Louisiana salt deposits supplied the nation. In the civil war, when the south was isolated by the Union blockade, teams by the hundreds from all sections of the southern states, were to be seen daily at the mines waiting in line for their loads.

With the establishment of peace after the civil war, a more systematic development of the properties was begun, which has led step by step to the highly efficient mining methods of today, permitting of an annual extraction of 300,000 tons at a minimum cost.

The great salt bed which lies along the coast in Iberia parish has been developed at two points, Week's and Avery's islands. While the salt crops out on the nearby mainland, the development has been confined to the islands.

Week's island in Vermilion bay, an arm of the Gulf of Mexico, is 125 miles by rail west of New Orleans. The island lies 204 feet above the waters of the bay, is nearly circular in form, and has a circumference of nine miles. The mine of the Myes Salt Co. is located on this island (at Weeks, La.), and has a productive capacity of 1,500 tons of salt daily. The island has been thoroughly prospected with diamond drills, and is underlaid entirely with the salt deposit.

The theory has been advanced by geologists that expansion, at the time of the crystallization of the brine, caused the island to rise high above the bottom of the bay and the adjoining mainland. Basing a calculation on the expansion having been 5%, they estimate the thickness of the deposit to be 4,000 feet. The deepest drill hole below the present workings shows the deposit unchanged at a depth of 1,200 feet.

The salt lies ninety-three feet under the capping of soil, and is 98.4% pure sodium chloride. It is mined through a 20x20-foot vertical shaft, 650 feet deep. By cementing a portion of the shaft, where sand strata were pierced in the first ninety feet, the mine has been made absolutely dry. The mining is done entirely on one level, and with the perfection of the present system of underground transportation, as the workings advance further from the shaft, it will be a question of years before it becomes necessary to open another level.

650-ft. Level of Myles Salt Mine.

The entire property, including the underground workings, is lighted by electricity. Drills operated by compressed air are used in the faces and stopes, and blasting is done with a special smokeless powder. As there is no foreign matter whatsoever in the deposit, the whole mass is removed, with the exception of occasional pillars to support the roof. The salt is mined up to a height of eighty-five feet above the station level. The great chambers which are left present, when lighted, a sight of unparalleled grandeur. The spectacular effect of the

* In Mining & Engineering World.

myriad crystals reflecting the electric lights is remarkable, and many of the country's noted personages have accepted the hospitality of the owners at the banquets which are served from time to time in this fairy-like palace beneath the surface.

The underground traction system centers near the shaft where the salt is crushed. The crushed material is then hoisted to the surface millhouse and dumped. By gravity it is run over a series of screens, which classify the d f-ferent grades. Gravity then leads the finished products into cars or to the loading floor.

The output is shipped to nearly every country, the world-wide demand being due to its exceptional purity. Classificatoin of the product is based only on the fineness of the crushing, as the salt is all of the same quality. Salt is furnished in lumps for stock and is crushed for grades A and No. 1, for ice cream making and car refrigeration. Grade No. 2 is used in great quantities for curing hides, making brine for pickles, etc. Table and bath salt are made by grinding the product to a very fine mesh. In addition, a special packing salt is provided for the heads of meat barrels.

The steam plant on the property consists of four boilers furnishing 500 hp. The cage with a capacity of four and a half tons, the electric plant, the mills and the machines for the sewing of bags are operated from the one battery of boilers. Oil is used as fuel.

It is the intention of the owners of the property to install an electric haulage system in the mine in the immediate future. The plans provide for a belt line to run near the edge of the present stopes. Branches will be run to this line from points where work is in progress.

The output of the property is constantly increasing, as is the force of employes.

At present the entire output of the salt mines is handled by rail, as the waters of Vermilion bay are too shallow to admit vessels, but with the completion of the projected intercoastal canal, the advantages of water transportation will reduce the cost of marketing the salt, giving this region even more right to be known as the "salt cellar of the United States," than its cane production entitles it to the time-honored sobriquet of "America's sugar bowl."

———o———

For chain sheaves, the diameter if possible should not be less than 20 times the diameter of the chain used.

———o———

The loss due to valves in pipes has been determined to be about six diameters of length of pipe for a fully open gate valve.

SOUTHERN RUSSIA'S "PORPHYRY" COPPER MI

By FREDERIC W. CAULDWELL.*

American capital is largely interested in the Caucasus Copper Company, which was formed in London in 1900 for the purpose of taking over and developing copper properties about fifty miles from Batum, which had been worked in the time of the Genoese; several centuries ago.

Up to the present time the company has expended over $8,500,000 on the property, but only recently has it been brought to a stage where the plant will pay operating expenses with a margin of profit. The development of the mining property has been slow because the ore is most difficult to treat, the copper being so finely disseminated through the rock that fine crushing is required, with the slimes resulting therefrom.

A magnetic plant was first erected, but was found unsatisfactory, partly because of the difficulty of cooling large quantities of red-hot ore to the stone coldness required in separating the ore from the silica. Enough of the latter mineral remained attached to the bits of magnetized metal to render the concentrates produced too siliceous for economical smelting.

Water concentration is now being used successfully. It yields a concentrate that can be smelted with less than 15% of oil and gives a recovery equal to that of the low-grade ores of Utah and Nevada.

At the present time an extensive campaign of development is about to start at the mine, and one plant extension is already under way. It is proposed to increase the crushing, concentration, roasting, and smelting equipment to a capacity of treating 1500 and probably 2000 tons of ore per day of twenty-four hours. The plant now treats 500 tons of ore per day. In view of these intended extensions, a description of the equipment and operation of the present plant is given.

ORE OCCURRENCE.

The mines contain at the present time, so far as is known from development work already done, 5,000,000 tons of 3¼% coper ore. It is known that there are extensions to this body far beyond that tonnage which have never been developed, as the present tonnage is sufficient for a number of years to come. It is proposed within the next year to resume diamond drill work to thoroughly test the areas upon which no development work has been done and under which the (is known to continue.

The ore occurs on a steep n side in a flat body varying in tl from eighty to 120 feet. The ove to be removed amounts to one-th ton for each ton of ore. The v the tonnage of ore thus far de can be mined with quarry work planned to remove the overburd of which is soft earth, by mean draulic giants, which will be than steam-shovel work.

These conditions, in connecti the cheap labor, will permit of ceptionally low cost for mining, with a tonnage of 1,500 tons p would probably equal the lowest tained at the large porphyry m Utah, Nevada, or Arizona. Wi mines opened up and the overbu moved it is estimated 2,000 or 3,(of ore could be supplied daily to centrator.

MILLING MACHINERY.

The ore is carried from the : 4-ton double-hopper cars by a sho to a crushing mill having a cap 1200 tons every twenty-four hour mill contains four 18x24 in. Blake ers and eight sets of 15x36-in. rig Automatic feeders supply the fi of crushers, which grind to 2½-i mum size. The ore is then carri Robbins belt conveyor to a 500-t above the second pair of crushers crush to 1½ in. Automatic feed also employed here.

From the Blakes the ore is ca a belt conveyor to a bucket elev the top of which it is discharged two units comprising the eight rolls. Each set of rolls is equipp its own elevator and trommel, the material already fine enough through the trommel is not sent the corresponding set of rolls, t creasing the formation of slime first set of rolls has a ⅞-in. t and the two pairs of fine rolls 5-millimeter (millimeter equal .(trommel.

The ore crushed to a 5-millimet is delivered to an aerial ropeway Pohlig system, similar to the B system in use in the United Stat carried to the concentrators on ft. lower level. There it is divi tween two concentrators, each h capacity of 250 tons every twe

* United States Vice Consul at Batum.

hours, and is fed from stock bins by automatic feeders to the boot of a vertical elevator, at the top of which a stream of water carries the ore to six jigs. In these all sizes of ore below 5 millimeters are jigged. The tailings from the six jigs go to revolving screens with 1½-millimeter holes, from which the oversizes go to an Evans-Waddell Chile mill, equipped with 1½-millimeter screens.

The ore from the other compartments of the classifier is sent to a row of ten and six tenths foot Frue vanners. The pulp is divided over the vanners in the proportion required by the tonnage produced in each of the sizes of the hydraulic classifiers. Each of these ten vanners thus treats between twenty and twenty-five tons of ore per day. The tailings from each group of these first-treatment vanners go to a bucket elevator attached to each group. After being elevated the tailings are again classified and treated a second time, a group of twenty vanners re-treating the tailings from the first ten. A fourth row of ten vanners is used to give a double treatment to the slimes obtained from the overflow of the classifier. These slimes are collected in eight wooden tanks, ten feet in diameter and eighteen feet high.

UP-TO-DATE METHODS.

The concentrates produced average approximately 8½% coper, 37% silica, and 28% sulphur. They are sent to concentrate storage bins and from there delivered to MacDougal roasters, 18 feet in diameter, and of the usual type used in the large copper smelters of the United States. The red-hot calcines mixed with limestone are delivered to three reverberatory smelting furnaces, two of which are thirty-five feet in length and one fifty feet. All are fired with oil.

The property is equipped with an excellent machine shop and a foundry of a size usually found only in plants of several times the capacity of this. These large shops are found necessary owing to the distance and time required to obtain spare parts.

The mines and smelter use oil for fuel exclusively. The oil is brought fifty miles from Batum by the company's own pipe line through four-inch Mannesmann high-pressure pipes. The oil used is that produced in the Caspian oil fields and is brought from Baku to Batum in tank cars.

The concentrators are all of the most up-to-date American machinery. In the smelter and the crushing mill the machinery is partly of English and partly of American manufacture of the most improved types. In extending the plant, the company will install equipment on the same general lines as that now in use.

At the present time over 1,100 men are employed in the mines and the smelting works and in construction. The labor is cheap and fairly efficient. A great variety of nationalities is found at work in the different departments. The miners are chiefly Greeks and Turks, with Persians working in the crushing mill. At the concentrators the laborers are Russians, Turks and Georgians. In the machine shop and foundry Russians and Georgians are to be found almost exclusively, while at the smelter the labor is exclusively Persian.

When the company took hold of the property in 1900 it found itself located about fifty miles from the seaport of Batum. The government macadamized military road covered thirty-five miles of this distance and the remaining fourteen miles the company was obliged to construct at great expense. This road had to be built along the face of mountains through rock and sliding soil. During the ten years of its existence the company has conveyed in wagons 10,000 tons of supplies, machinery, and product over this fifty miles of road.

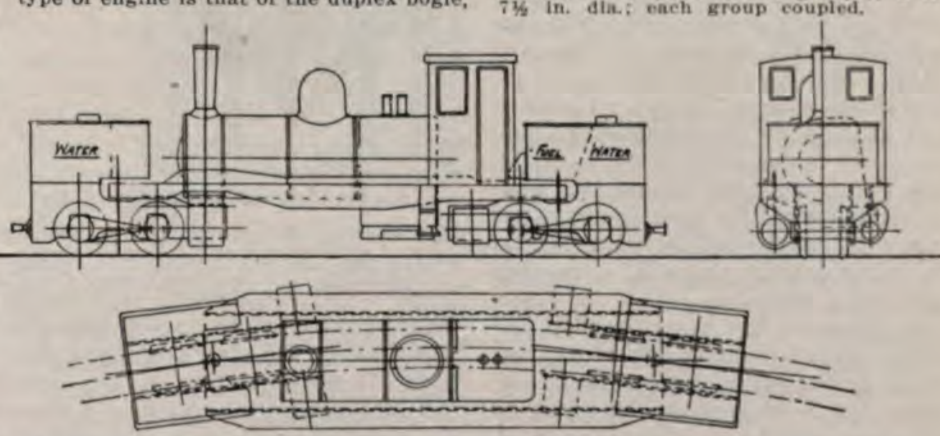
All the copper produced by the company is sold in Russia and commands a good price, as the duty on foreign copper imported into Russia is 5 rubles ($2.575) per pood (36.5 lbs.).

The property in point of ore tonnage developed is today one of the large mines of the world, and there is every indication that with the extension of the ore body known to exist but not yet prospected it will develop into one of the largest. The mining company is the largest buyer of American products in this part of the world.

Locomotive for Sharp Curves

The Tasmanian Government has had a Garratt engine in operation on the N. E. Dundas line (2 ft. gauge) for several years past, and it has proved so successful in negotiating the sharp curves, which are a feature of that line, that railway engineers from all over Australia have visted the district to see it at work, says the Australian Mining and Engineering Review.

The general arrangement of this new type of engine is that of the duplex bogie, but beyond this it has little in common with other known types. Instead of the boiler being placed above the wheels, as has hitherto been the practice, it is carried upon a girder frame slung between two bogies. This allows the firebox to be as wide as the loading gauge if desired, less the distance required for the width of the sides of the cradle frame, which is, in any case, only a few inches. The bogies, with their water tanks and coal bunker, together constitute the greater part of the weight of the locomotive, and give stability to the running; furthermore, the centre line of the boiler portion connecting the two bogies forms a chord of the curve on which the engine may be traveling, and the sharper the curve the greater will be the projection of the boiler weight towards the centre of the curve.



MAIN DIMENSIONS.

Gauge, 2 feet.

Cylinders, 2 pairs; 1 pair h.p., 11 in. dia. x 16 in. stroke. 1 pair l.p., 17 in. dia.

Wheels—4 pairs (in 2 groups), 2 ft. 7½ in. dia.; each group coupled.

Wheelbase—4 ft. each group. Total, 26 ft. 9 in.

Boiler—7 ft. long, 3 ft. 11⅝ in. dia.

Tubes (170)—1¾ in. dia. outs.

Firebox—3 ft. 5 1-16 in. long x 4 ft. 3⅞ in. wide x 4 ft. 2 in. high at front and 4 ft. 0½ in. high at back.

Heating Surface—

Tubes	568 sq. ft.
Firebox	60 sq. ft.
Total	628 sq. ft.
Grate Area	14.8 sq. ft.

Working Boiler Pressure—195 lbs. per sq. inch.

Tanks—

Smokebox end	510 gallons
Firebox end	30 gallons
Total	840 gallons

Fuel Space—1 ton of coal.

WEIGHT OF ENGINE ON RAILS.

	T.	C.	Q.
In working order with water and fuel tanks full.			
Bogie at Smokebox end..	16	5	1
Bogie at Firebox end....	17	5	2
Total..................	33	10	3
With water and fuel tanks empty.			
Bogie at Smoebox end...	14	1	1
Bogie at Firebox end....	14	13	3
Total..................	28	15	0

Co-efficient of Adhesion Tanks full, 5.3.

Co-efficient of Adhesion Tanks empty, 4.5.

Engine designed to work up grades of 1 in 25, with curves 1½ chains radius.

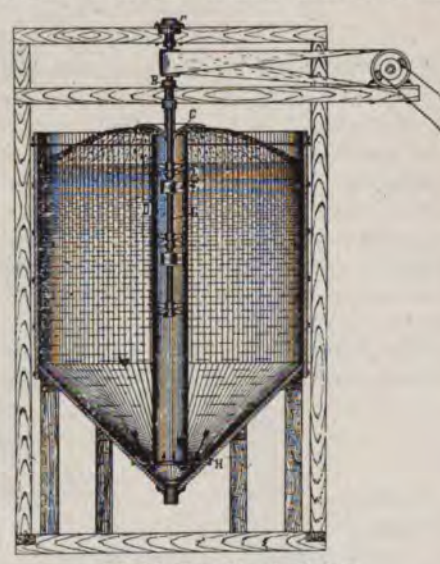
WOOD CYANIDE AGITATOR

The question of durability in an agitator is second only to that of perfect agitation and areation. The P. K. Wood Pump Co. of Los Angeles, Cal., has developed and put on the market an agitator in which is employed as a means of circulating and aerating the cyanide solution, the propeller pump, invented and patented by P. K. Wood.

The accompanying illustration shows this agitator, the interior of which is so constructed that there are no bearings within the solution, consequently no wear on any of the submerged parts of the pump coming in contact with the sand and solution. The shaft G is large enough in diameter to prevent any vibrations without receiving any support from the guides F, which do not come in contact with the shaft G, as the only function of the guide is to control the slight whirling motion imparted to the solution by the impellers E. The two shaft boxing, A and B, are placed far enough apart to prevent any vibration of the shaft where it extends down into the pump casing and solution, thus placing all the bearings beyond the reach of the solution. The shaft and impellers are supported by ball bearings, located on top of the box boxing A, where they are easily accessible.

In operation, the entire solution and sands are kept continually in motion; exposing the entire solution to the air every 10 to 20 minutes, according to the speed at which the pump is operated. The solution is distributed over the surface of the tank by the circular convex deflector C, which may be raised up until it is not reached by the solution, allowing it to flow undisturbed over the pump casing D, or it may be lowered until it forces the solution to the very verge of the tank in one solid circular sheet, or under such pressure that it spreads out in a thin sheet with great velocity, enabling the operator to give more or less aeration to suit his individual views. The amount of power required depends on the diameter of the tank, and the amount of aeration desired. The principal requirement of power being that of distributing the solution over the surface of the tank. Therefore it is preferable to use a deep tank with moderate diameter, rather than one of large diameter and equal capacity, for not only will the smaller diameter and deep tank give better results in agitation with less power, but the first cost will be less, as the cost of the agitator pump depends, not so much on its length, as it does on the volume of solution to be handled, requiring a pump of greater capacity for the larger diameter tank.

The distribution of the solution near to the outer edge of the tank insures perfect and uniform agitation of the entire contents of the tank; for the solution dropping in a heavy circular sheet around the outer edge of the tank creates a current downward around the entire circumference of the tank, which passes over the conical bottom of the



Wood Cyanide Agitator.

tank moving toward the center, undermining the solution, causing it to settle evenly toward the apex, where it enters the pump to be taken up and delivered back again on the surface over and over again continuously. It is obvious that with this mechanical appliance, the entire solution and the sands in continuous circulation, there is no opportunity whatever for the sands and slimes to concentrate at any point in the process of agitation, for should the sand settle rapidly toward the apex of the bottom of the tank, they are immediately taken up by the pump to be discharged on the surface again, leaving no opportunity for the choking up by the sands. If it is desirable to fill the pump with the ore before starting, pipes or scantling may be set in the tank with the lower ends in the apex of the conical bottom. When the pump is in operation, draw these out, and through these openings the solution will be drawn by the pump with such velocity as to tear down the walls of sand and set it all in motion.

It is not anticipated that the agitator tank shall be used as a leaching tank, yet this may be done if desired; in which event it would be preferable to use a flat-bottom tank with false conical bottom, with filter covering the flat bottom, and the sides of the tank also if desired, with suitable discharge opening, to which may be attached a vacuum pump if required; and the agitator pump would be kept running during the leaching process, thus aiding the leaching by preventing the settling of the sands and slimes; and as the propeller pump is capable of handling at least 75% of solid matter on a vertical lift, the greater part of the strong solution could be filtered off before adding fresh water.

WIRE ROPE PRESERVATION

When a complaint is made that a wire rope has not given satisfactory service, the first questions asked by the manufacturer are, How was the rope lubricated? What is the condition of the inside wires?

These questions arise, because the experienced wire rope maker fully appreciates that a wire rope is a complex piece of machinery, and knows that the importance of proper lubrication is too often overlooked.

Sometimes a wire rope is covered with a compound too thick to penetrate beyond the outside wires. The effect of this is to leave the inside wires without protection against water and moisture.

Examinations of ropes that have fallen short of the period of good service which might be reasonably expected, frequently show the outside wires in apparently good condition, while the areas of the inside wires have been materially reduced and the whole rope weakened. This is due to the corrosion that could have been prevented by the use of a lubricant which would have reached and protected the inside wires. Because of this, a lubricant or preservative should not only penetrate to the hemp center (in order to saturate it and prevent absorption of water), but it should also thoroughly coat the inside wires of each strand.

This cannot be expected from thick, heavy and sticky compounds and greases frequently used for the lubrication of wire ropes, although made primarily for some other and quite different purpose.

Experience has shown that the best results in the protection and preservation of wire rope by lubrication are obtained only when lubricants made especially for this purpose are used.

Mines and Methods

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CONTENTS:

Ex-Mayor John S. Bransford returned from a four months' trip to the coast a few days ago. And, say, you ought to see the reception he has been and still is being accorded. People here have learned since the first of the year that they dropped a pearl to pick up a pin when they discarded him for Sam Park. They are beginning to appreciate what an honest, progressive business administration of a city's affairs by a dead square, open-countenanced, fair business man is worth to a community like this.

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During the month of February representatives of the government weather bureau service went out and measured the snow-fall in the mountains for the purpose of determining how short of water this city would be during the coming summer. What's the matter with having a second measuring expedition? It is said there is now more snow at Brighton, at the head of Big Cottonwood canyon, from which the main supply of water for this city comes, than has been known there for many years.

CONGRESS TINKERING WITH MINING LAWS

By the provisions of a bill to amend section 2322 of the Revised Statutes of the United States relating to mineral locations," which was introduced in the United States senate by Senator Reed Smoot on the 5th of the present month, another move is made in the long-pending efforts of a large percentage of those interested in metal mining to do away with the trouble-breeding "law of the apex," so-called. Without in any sense wishing to question the motives of Senator Smoot, it is urged on mining men of the west—and all over the country, for that matter—that right now is the time to inaugurate a campaign that should result in making this measure of revision of the mining laws all that it ought to be. There is little in the measure introduced by Senator Smoot showing that the subject has received any particular attention, thought or study on his part, and it is remarkable that such a proposition could be made by a western senator, engaged in mining, with so evident a lack of knowledge of what will be necessary in the change of present laws governing the location of mineral lands, to meet present day requirements and avoid trouble for the future. This new proposition is known as Senate Bill 6194. It has been twice read and referred to the senate committee on public lands. Mining men who are and should be interested in seeing a comprehensive law enacted should make themselves heard by the committee having the subject in hand. The Smoot bill reads as follows:

Sec. 1. Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, that Section 2322 of the Revised Statutes be, and the same hereby is, amended to read as follows: "Locators of all mining locations heretofore made on any mineral vein, lode or ledge situate on the public domain, their heirs or assigns, shall have the exclusive right of possession and enjoyment of the lands so located and of the veins, lodes or ledges apexing therein, as permitted by the customs, regulations and laws in force at the date of their locations, but from and after the passage of this act the locators of mining locations upon any mineral vein, lode, or ledge, or of a deposit of mineral or minerals in place, situate on the public domain, their heirs or assigns, shall, subject to such other rights as pertain to claims located prior to the passage of this act, have the exclusive right of possession and enjoyment of all the surface included within the lines of their locations and of such veins, lodes, ledges, and deposits of mineral or minerals in place as lie within the block of ground bounded by vertical planes passing through such surface lines, and no such locator, his heirs, or assigns, shall have the right under such location to follow any vein, lode, ledge, or other deposit outside of the limits of such claim.

"Sec. 2. That notice of location of all mining claims, lode, or placer, made after the date of the passage of this act, must be filed for record with the register and receiver of the land district within which the lands are situated within one year from the date of each location, and unless final entry and payment be made for such claims within seven years after date of location, exclusive of the time covered by pending adverse claims, all rights thereunder shall cease."

It will be noted at first glance that the measure is woefully lacking in detail; that, made into law as it is, it would prove a more fruitful source of litigation and trouble of all kinds than does the law it professes to amend. And the law of the apex is only one of many features of present day stumbling blocks found in our mineral statutes. A general revision is needed—a fact that has recently been given particular emphasis in the construction that has been placed on some provisions by the clerical snobs who make decisions for the general land office. A case in point is the recent ruling that the owner of a mining location, before he can secure government title (patent) to his land must first show that he has developed a PROFITABLE, PRODUCING MINE. This is conceded to be the biggest fool ruling of all the fool rulings ever promulgated by the land office, and it serves to emphasize how necessary it is that—if the industry of minig is to be preserved—no "tinkering" with present laws be permitted; that if any changes are made, they be wholesome and comprehensive ones.

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In figuring grade resistance (or assistance) add or subtract 20 pounds per ton for each per cent of grade.

TREND OF THE TIMES

Who is to blame for the terrible, wanton sacrifice of human life which resulted from the wrecking of the mighty ocean greyhound, the Titanic, on the night of April 14? Was it Captain Smith? Was it the company which ordered the ship built? No? Who was it—what was it—then? Everybody has formed or will form some sort of an opinion and these opinions will find expression publicly, or privately and carry weight according to the knowledge or lack of it—training, sentiment, superstition or belief of the individual units of humanity capable of conveying their impressions to others.

The responsibility for this appalling loss of life and the desolation it will bring to thousands who were left behind by those who perished will no doubt be saddled upon some one by what we are pleased to term lawful authority. The company owning the ship will be made culpable for not having provided a greater number of lifeboats and Captain Smith, who probably simply obeyed orders from his employers and went to his death while executing them, is apt to have his memory sullied through some "investigating" report charging that he should never have sailed from Portsmouth without seeing that his vessel was so equipped that shipwreck could not result in loss of life. Such is the trend of the times.

And let us here state that it seemingly is "the trend of the times" which should be charged with the fate of the Titanic and not a few individuals in the mass of millions striving, surging and swaying in the never-ceasing endeavor to outdo each other. A ship is built that sails faster than any previously built and the nervous world never halts till that accomplishment has been surpassed. The largest ship is launched and somebody immediately makes a move to secure a still larger and speedier vessel. Mechanical engenuity is placed at a premium and the new ship is conceived, planned and constructed. The mariner rebels and pleads that the latest effort is tempting fate and the elements; he is laughed to scorn and the world registers a deafening demand for the accommodation the "new floating palace" will provide. The shipmasters and their crews, per force, must either applaud the newest move to defy the elements or pass into obscurity as being "out of date." It is the trend of the times.

The trend of the times—these modern, rushing, hot-foot times—find its most fitting exemplification and definition in the combination of wealth and energy financially and commercially described in the two words: "BIG BUSINESS." It is "big business" that makes the world hum; it is the demands of "big business" that increases the size and speed of ships, railroad locomotives, automobiles, flying machines and balloons; it is "big business" that forms trusts and plans mergers and transforms night into day and day into night; and God has seemingly found it out and has called a halt. His displeasure is being expressed in the warnings given through the disasters accompanying reckless aerial flight; through the ravages of earthquake, typhoon and flood; through the rumblings of war and the almost universal discontent of the masses of the world's inhabitants. The pace has been made too swift; there will have to be a slowing down.

GETTING READY TO UNLOAD

An issue which is about to be offered to the public in a larger way than heretofore is the Guggenheim Exploration Co., which now has its press agents calling attention to the assets piled up in the company's treasury, in the shape of holdings in Utah Copper, bought some years ago at low prices, and which is nearly all c.ear profit now. It is stated that just before the recent rise in Smelters, the Exploration company bought a large block of stock at an average of $70.

The Guggenheim Exploration shares are to be listed on the New York Stock Exchange, but the par value is to be reduced to $25 by issuing new stock in exchange for the old on a basis of four shares for one now held; the object beinging to make the issue less unwieldy. At present figures, a hundred shares of stock comes to $22,000, a price that does not look very attractive to speculators as it ties up too much capital.

By way of further market news it may he said that Utah Copper has been under quite heavy pressure; some large holder is stated to have been liquidating holdings around $60, selling in 5,000 share lots. Underground work in the Boston ground of the Utah Copper has ceased, as the miners have struck for an increase of pay to $3.50 for miners and $2.75 for trammers.—New York Correspondent Mining and Scientific Press.

Here is a case wherein it would seem to be perfectly justifiable to "take that correspondent into camp." He will surely help kill the game if allowed to roam at large. See how much better it would be if the correspondent quoted above talked like Thomas C. Shotwell who, on the 17th of this month was quoted by the Salt Lake Tribune as follows:

Utah Copper is the one copper stock that has not discounted to any appreciable extent the improvement of the metal market. It is the richest of all the group and is selling comparatively the lowest. Its forthcoming report will show a remarkable increase of ore brought into sight. Buying of the stock is of the best character.

It is understood that a party of copper men will go from New York this week to visit the Utah copper mines. This may be a matter of no importance or it may mean that plans have been revived for the great copper merger that was attempted two years ago. The agreement regarding the output has worked so well that a legally organized trust seems unnecessary. But in view of the collapse of the Sherman anti-trust law it may be that the old plans will be revived.

Some "class" to that kind of "dope," whether it is true or not.

COPPERETTES

On the 15th of the present month more than 1000 Salt Lakers—men, women and school children—journeyed over the $5,000,000 "scenic line" of the Utah Copper Company—the B. & G. railroad—as excursionists to view the wonders of Bingham. It is presumed the drill hole through which 100,000,000 tons of new ore was added to the mine's "blocked out" reserves last year, was shown to the visitors, each one of whom was cautioned not to go too close to the brink of the hole for fear of becoming "giddy" and falling in.

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Judging from the report of the New York correspondent of the Mining and Scientific Press, some big holder of Utah Copper was unloading early in the mouth. Inside interests were compelled to take the stock in blocks as big as 5,000 shares each in order to keep the price up. It is certain that the feverish desire of the pooled crowd to distribute Utah shares with the public at large is not yet being encompassed with any material degree of success, notwithstanding the "buoyancy" so persistently heralded in the market reports and subsidized press.

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The action of the Guggenheim Exploration Company in increasing its number of shares and cutting down the par value of the stock to make it "less unwieldy," and the announcement that the new stock will be listed on the New York exchange, suggests the thought that the company has hit on this scheme of handing the public its large block of Utah Copper, a market for which it has been impossible to make as a separate proposition. The idea seems to be that "if we can't sell Utah Copper stock, let's hand it to 'em in the form of Exploration shares."

* * * *

The annual report of the Utah Copper company is, at this writing (April 23) still withheld from the public. It must be a weighty document this time, and since Mines and Methods "butted into its contents" a month in advance of its official promulgation, the "construction committee" has probably considered it necessary to make some changes. We are sorry that we cannot review the precious morsel this month; but it will keep.

ASON VALLEY MINES AND SMELTING WORKS

By AL H. MARTIN.

holdings of the Mason Valley Company, to which wide attennow being drawn through smeltallation, market activities, etc., es seven claims and a fraction in son Valley mining district, Ne- The properties lie about one and miles west of the town of on the Nevada Copper Belt rail- A wagon road of moderate grade s the mines with Mason, afford- ellent and rapid connections e main line. Operations com- at the mines March 1, 1907, and at date the uncertain prospects en gradually developed into the nportant copper producer in Nevada. The ore formation is lly limestone, with the ore de- argely located on the east side orth and south fissure. Copper s predominate, with some oxi- aterial near the surface. The ange from a few feet up to 80 e with values increasing as the is neared. In the lower levels ore deposits have been demon- Diamond drilling has resulted intersection of zones carrying rite below the main levels. arge orebodies have been proven he huge vertical fissure, and re expected to eventually unite main deposit. Ore values range out 2.25 to 3.75 per cent cop- ton.

E IS WELL OPENED UP.

pments consist of three main adits, intermediate levels and prehensive system of drifts, and raises. In all 15,136 feet of s been accomplished, according t reports of the management. dit was driven ninety feet below rops and was the first compre- work undertaken. Results satisfactory an intermediate s sent 130 feet lower. Fifty ow this Adit No. 3 was driven. osits continuing to show excel- ength as depth was gained, it ided to drive an intermediate ty feet below No. 3. With the nation of this work No. 4 adit, feet deeper, and a drift seventy w the new adit, were extended. re a total vertical depth of 480 ow surface. Ore shoots were ll the way down, and early in diamond drill was installed in dit and vigorous prospecting of the North Excelsior claim undertaken. A depth of 760 feet was gained when the shortage of water compelled temporary cessation of activities. The drill disclosed bodies of chalcopyrite ore and as soon as sufficient water is available it is likely that further drilling will be undertaken. Of the total amount of developments accomplished, crosscut adits and drifts represent 9,466 feet, and lateral crosscuts 2,853 feet, while 2,443 feet of raises have been driven, together with 371 feet of shafts and winzes.

In developing the mines drifts have been run north and south following the general trend of the orebodies, while crosscuts have been driven east and west. The ground breaks and stands well, with little timbering required. All of the ore above No. 4 adit is broken down into the levels and loaded directly into the cars. Consequently there is no necessity for hoisting ore above this point, natural conditions being particularly favorable for low mining costs. Until considerable mining at depth is undertaken, pumps will not be used. During the construction of the smelting plant, little effort was made to extract ore aside from that produced in course of developments, and the company has a large tonnage blocked out. This can be extracted with little dead work for a considerable period. With 300 to 500 tons produced daily, it is estimated mining and development costs will not exceed $1.25 per ton of ore.

EQUIPMENT AND TRANSPORTATION.

The machine-drills are supplied with power from an Ingersoll-Rand compressor of 576 cubic feet capacity. Seven Ingersoll-Rand and six Waugh machine drills are employed. A Westinghouse C. C. L. induction motor of 100 horsepower delivers 440 volts to the mine machinery. Three Westinghouse 27.5 kilowatt transformers steps down the current from 2,200 to 440 volts for delivery to motors. The ore is shipped to the railway cars at Mason from the mines by an aerial tramway 1¾ miles long. From Mason the ore-cars are taken over the Nevada Copper Belt railroad to the smelter at Thompson, 16½ miles distant. A traffic agreement exists between the railroad and the Mason Valley company for the handling of this ore.

From the railroad cars at the smelter terminus of the railway, the ore is

General View of Main Portion of Mason Valley Mines, Showing Various Operating Tunnels, Mine Terminal of Ore Transporting Tramway, Etc.

Panoramic View of Mason Valley Smelter at Thompson, Sixteen Miles From the Mines—Walker River in Background.

loaded into 50-ton dump-cars and delivered to the sampling mill. The ore is first crushed in a No. 8 gyratory crusher and delivered to samplers of the Vezin type. Between each sampler the ore is crushed before further bulk reduction. The sampling mill has a capacity of 100 tons per hour. After sampling, the ore is received by belt-conveyors and distributed to twenty ore-bins. Each of these has a capacity of 200 tons. Ample coke storage has been provided for a stock sufficient to run the plant several weeks in excess of requirements—to avoid stoppage of operations should interruptions of shipments develop.

MASON VALLEY SMELTER.

The blast furnace building is constructed of steel. Two blast furnaces, each having a rated capacity of 400 tons per day, have been provided, but the solitary furnace in commission is treating from 450 to 500 tons of material per day. Ample space has been provided for the future installation of three more blast or reverberatory furnaces and two converters. The blast furnaces are of the water-jacketed drop-bottom type, with dimensions of 46x300 inches at the tuyeres. Each furnace has 24 jackets, with 25 tuyeres on each side. The spout is at the end of furnace and delivers into a small forehearth. The ore from the bins is dropped through chutes into an automatic scale and is loaded directly from the scale into the charging train. This consists of six cars, operated by an electric locomotive. The cars run directly underneath the scale. Besides the sulphide ore coming from the Mason Valley mines, a considerable portion of the charge consists of carbonate ores from the Nevada Douglas properties, at Ludwig, in the same district. The union of these ores makes a nearly self-fluxing charge, only about 5 per cent of lime rock being required.

From the small forehearth receiving the slag and matte from the furnace spout, the products flow into a large settler. Blast is supplied to the charge by two Connelsville blowers, operated by electric motors. The blowers have a capacity of 275 cubic feet. The blast pressure ranges from 30 to 38 ounces. The blowers are operated by power obtainable from two different stations, to guard against the shutdown of blowers in case of accidents to either one station. The matte varies from 42 to 50 per cent, the company endeavoring to produce a product always averaging over 40 per cent copper. At present the matte is tapped into a casting machine, but it is understood this will probably later be replaced by a large circular settler of ordinary design. The product is sent to Garfield, Utah, for further treatment, but the future plans of the company include the probable installation of converters to transform the matte into blister copper.

The brick furnace stack has a height of 200 feet and is self-sustaining. It has an interior diameter of fifteen feet at the top, and is located about 400 feet above the valley. Large flues and dust chambers have been provided to arrest the fine dust. The Dwight & Lloyd sintering process is used for the sintering of fine ore and flue dust. The slag from the settler is hauled to the dump piles in 20-ton slag-pots, drawn by electric locomotives. The sampling mill building is composed of steel, and the power house is constructed of brick. Three 500 kilowatt oil-insulated, water-cooled transformers are located in the power-house, together with a motor generator, furnishing power to the electric locomotives.

Aside from the main installations, the company has provided machine, sheet metal, blacksmith and carpenter shops. A concrete reservoir has been provided to guard against fire, this being at an elevation to provide a strong gravity pressure. A complete fire-fighting system has also been installed. The plant is one of the most modern in the country and it is planned to gradually enlarge it into one of the largest in the west. The smelter equipment was installed by the Traylor Engineering & Manufacturing Co.

DOES CUSTOM BUSINESS.

In addition to the ore treated from the Mason Valley and Nevada Douglas copper mines, a large amount of gold-bearing custom material is received at the smelter from numerous small mines in territory tributary to the plant. This factor is expected to develop into a highly profitable industry, as hitherto lack of reduction facilities has been one of the greatest factors militating against operation of small mines in this section of Nevada. Thus, the Mason Valley plant is exercising a beneficial effect upon gold mining throughout Mason valley and even as far as the vicinity of Reno. As this business develops, and production of ore increases at the Mason Valley and Nevada Douglas mines, it is probable the second furnace will go into commission before the close of 1912.

Just below the smelter the company has undertaken the building of the town of Thompson, named after President W. B. Thompson of the Mason Valley Mines Company. It boasts a modern hotel and about twenty houses, and is steadily gathering importance. Climatic conditions are favorable. Construction work started on the smelter in November, 1910, and the first furnace was blown in January 6, 1912.

ODERN THEORIES OF ORE DEPOSITION

By E. K. SOPER.*

ore deposit may be defined as a ntration in the earth's crust of lferous minerals of economic value. rm, ore, has been variously defined ferent students of the subject, but ollowing definitions suggested by nd Kemp probably cover all cases. text-book of Economic Geology, gives the following: "Under the ore, are included those portions of e deposit of which the metallic min- form a sufficiently large proportion re in the proper combination to their extraction possible and profit- Those minerals which carry the le metallic element within the t are called ore minerals. Kemp that a distinction should be drawn en the purely scientific use of the and the technical usage. He sug- the following definition:

the scientific sense an ore is a lferous mineral, belonging to the of those which have profitably d metals to the miner or metal-. In its technical sense an ore is alliferous mineral or an aggregate talliferous minerals, more or less with gangue and capable of being, the standpoint of the miner, won at it; or from the standpoint of the urgist, treated at a profit." It is y seen from a consideration of the definitions that the test of yield- e metals at a profit is the final one ploy in limiting the use of the term o its correct place. If we accept efinition, it naturally follows; then, hat may not constitute an ore to- ay become ore at some future date ason of improved methods of min- metallurgical treatment. Similarly, ial that is ore today may not be in the true sense of the word at re time, because of a decrease in arket value of the metal or a de- in the proportion of metals in the which is being mined.

study of ore deposits is a compara- new branch of the science of geol- The study of the genesis of ores is mparatively recent date, and the t state of our knolewdge of the t is far from satisfactory. The earliest contributions to this branch of the science were made by the German geologist Werner, in about 1791. At this date he advocated the theory that "mineral veins and eruptive dikes" were formed from sea waters by chemical precipitation. This theory met with little opposition except from a few, for the subject of ore genesis up to that time had been given little if any attention. Some years later, Hutton, an English geologist, expressed it as his opinion that dikes and veins were formed by the solidification of igneous magmas. Following this, other views were set forth by various students of the subject, until considerable interest was aroused, especially in Europe. Von Cotta developed his theory of fissure veins about 1859, and in 1882 Sandberger and his followers put forward their views on the subject, which later became known as the theory of lateral secretion. They held that ore deposits were formed by leaching of the metals from the rocks in the vicinity of the ore body, and the theory was based on the premise that the country rock must first contain the metals in some form, in order to furnish a source from which the ores could be concentrated by laterally moving solutions. Physical and structural conditions of the deposits, which we now recognize to be of the greatest importance in furnishing evidence of origin, were largely ignored by the followers of Sandberger.

From 1882 until late in the nineteenth century, the Germans led the world in the study of ore deposits. During the last ten or fifteen years, however, the development of economic geology as applied to mining has undergone remarkable development. The recognition of the economic value of this branch of the science is chiefly due to American geologists and it is to their efforts, largely, that we owe this great step forward. Perhaps one of the chief factors in stimulating the study of ore deposits in the United States has been the detailed investigation of a large number of the most important mineral deposits of the country undertaken by the United States Geological Survey.

ULTIMATE SOURCE OF THE METALS.

Geologists now agree that the ultimate source of the metals is in the igneous rocks. While this is an important step, there is still much difference of opinion regarding the sources of the solutions which carry these metals from one point in the earth's curst to another, resulting in concentrations of the valuable minerals in comparatively small areas, thus enriching the rock and forming ore deposits. The chief point under investigation, and regarding which geologists are still in disagreement, is whether the solutions which brought certain deposits to their present position, were of meteoric or magmatic origin. This is an important fact to establish in studying the genesis of a given deposit, for the depth of mineralization will often depend upon the origin of the mineralizing solutions. Unfortunately in many cases, this very important fact is the most difficult of all to establish. It is probable, however, that both meteoric and magmatic waters have played a part at some time in the history of most ore deposits, and it is to be hoped that the investigations of the next few years will add much evidence to this important phase of the subject.

CLASSIFICATION OF ORE DEPOSITS.

Ore deposits are classified into certain groups in order to facilitate their study and comparison. Various methods of grouping have been used by different students of the subject, and each has a certain value. For example, deposits have been classified with respect to their age relation with the country rock: (syngenetic, contemporaneous with the country rock; and epigenetic, of later age than the country rock). Deposits have also been classified with respect to metasomatic processes acting during their formation. Other classifications are based upon depth at the time of deposition, forms of deposits, etc., etc.

In studying a given ore deposit, the first thing to find out is what is there. After having determined what is there, the problem is to ascertain what has happened. If the geologist is fortunate enough to be able to make these important determinations, his problem is nearly solved, and it will require only the correct interpretation of his evidence to enable him to make the proper recommendations regarding its exploitation. Ore deposits assume such a great variety of forms and occur under such variable conditions that it is necessary to have some logical classification as an instrument in their investigation.

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*...artment of Geology, University of ...sota.

...F. Kemp; What is an Ore? Mining ...ntific Press, March 20, 1909, page

The following classifications by Kemp and Weed are given to illustrate two entirely different systems of grouping. Kemp's classification, based on the methods of deposition and the shape of deposits, is as follows: (*)

Excessively basic development of fused and cooling magmas. Peridotite, forming iron ore at Cumberland Hill, R. I. Magnetite, Jacupiranga, Brazil. Titaniferous magnetite in Minnesota gabbros; in Adirondack, N. Y. gabbros; in Swedish and Norwegian gabbros. Nickeliferous pyrrhotite, in gabbros and diorites derived from them.

(1) Surface precipitation, often forming beds, and caused by:

(a) Oxidation—bog ores.

(b) Sulphurous exhalations from decaying organic matter, (pyrite).

(c) Reduction, chiefly by carbonaceous organic matter, (pyrite from ferrous sulphate).

(d) Evaporation, cooling, loss of pressure, etc., (Hot Spring deposits, as at Steamboat Springs, Mo.).

(e) Secretions of living organisms (iron ores by algae).

(2) Dissemination (impregnations) in particular beds of sheets, because of:

(a) Selective porosity.

(b) Selective precipitation by limestone.

(3) Filling joints, caused by cooling and drying. (Miss. Valley gash veins in part.)

(4) Occupying chambers (caves) in limestone. (Cave mine, Utah.)

(5) Occupying brecciated beds, caused by solution and removal of support, or from dolomitization of limestone. (S. W. Missouri zinc deposits.)

(6) Occupying cracks or monoclinal bends, anticlinal summits, synclinal troughs, often with replacement of walls. (Gash veins in part; galena deposits at Mine la Motte, Mo., etc.)

(7) Occupying shear-zones or dynamically crushed strips along faults, whose development may be slight, closely related to No. 8. (Butte, Montana.)

(8) True veins filling an extended fissure, often with lateral enlargements. (See also under 5.)

(9) Occupying volcanic necks in agglomerates. (Bassic Mine, near Rosita, Colo.)

(10) Contact deposits. Igneous rocks almost always form one wall. Fumaroles.

(11) Segregations formed in the alteration of igneous rocks. (Chromite and serpentine.)

(1) Metalliferous sands and gravels, whether now on the surface (placers, magnetite, beach-sands) or subsequently buried, (deep gravels, etc.).

(2) Residual concentrations, left by the weathering of the matrix. (Iron Mt., Mo. Limonite in part.)

*J. F. Kemp; Ore Deposits of the United States, p. 53.

From the foregoing it will be seen that this classification makes no distinction between deposits from magmatic solutions and deposits from meteoric solutions, nor is the depth at which the various deposits were formed considered. On the other hand, the form, shape, and location of the various deposits are all treated in detail.

The following classification by Weed embodies the results of the more modern studies of ore deposits, and includes several types not given above.

CLASSIFICATION OF ORE DEPOSITS.

(After Weed.)

A. Igneous, magmatic segregations.
- (a) Siliceous.
  1. Masses, aplitic masses. Ehrenberg, Shartash.
  2. Dikes, beresite or aplite. Berezovsk.
  3. Quartz veins. Alaska, Randsburg, Black Hills.
- (b) Basic.
  1. Peripheral masses, copper, iron, nickel, Sudbury, Ontario.
  2. Dikes, titaniferous iron. Adirondacks; Wyoming.

B. Igneous Emanations. Deposits formed by gases above or near critical point (365° C. and 200 atmospheres for H_2O).
- (a) Contact metamorphic deposits.
  1. Deposits confined to contact, magnetite deposits, (Hanover, N. Mex.), chalcopyrite deposits, Kristiana type; gold ores, Bannock, Idaho, type.
  2. Deposits impregnating and replacing beds of contact zone. Chalcopyrite deposits, pyrrhotite ores, magnetite ores, Cananea type, gold-telluriun ores, Elkhorn type, arsenopyrite ores, Similkameen type.
- (b) Veins closely allied to magmatic veins and to division D.
  1. Cassiterite. Cornwall.
  2. Tourmaline copper. Sonora.
  3. Tourmaline gold. Helena, Mont., Minas, Geraes.
  4. Augite, copper, etc. Tuscany.

C. Fumarolic Deposits.
- (a) Metallic oxides, etc., in clefts in lava. No commercial importance. Copper, iron, etc.

D. Gas-aqueous or pneumato-hydato-genetic deposits, igneous emanations, or primitive water, mingled with ground water.
- (a) Filling deposits.
  1. Fissure veins.
  2. Impregnation of porous rock.
  3. Cementation deposits of breccia.
- (b) Replacement deposits.
  1. Propylitic. Comstock, Nev.
  2. Sericitic, kaolinic, calcitic, copper, silver, silver-lead. Clausthal. De Lamar, Idaho.
  3. Silicic dolomitic, silver lead. Aspen.
  4. Silicic calcitic. Cinnabar, California.
  5. Sideritic silver lead. Coeur D'Alene, Slocan, Wood River.
  6. Biotitic gold, copper. Rossland, B. C.
  7. Fluoric gold, tellurium. Cripple Creek.
  8. Zeolitic. Michigan copper ores.

STRUCTURAL TYPES OF ABOVE.

- Fissure veins, San Juan, Colo.
- Volcanic stocks. Nagyag, Cripple Creek.
- Contact chimneys. Judith.
- Dike replacements and impregnations.
- Bedding and contact planes. Mercur.
- Axes of folds, synclinal basins, anticlinal saddles.
- Bendigo, Elkhorn.

E. Meteoric Waters (surface derived).
- (a) Underground.
  1. Veins. Wisconsin lead and zinc.
  2. Replacements. Iron ores, Mich., lead, zinc.
  3. Residual. Gossan iron ores, manganese deposits, Virginia.
- (b) Superficial.
  1. Chemical. Bog iron ores, sinters. Some bedded iron ores, etc. Clinton ore.
  2. Mechanical. Gold and tin placers.

F. Metamorphic Deposits. Ores concentrated from older rocks by metamorphism, dynamic and regional.

The two classifications given above were not selected because they were considered the best, or because they are especially simple, but for the reason that, as stated above, they are representative, and illustrate two entirely different methods of grouping. Other geologists have devised excellent classifications, each of which has caused certain deposits to be inspected more carefully with definite premises in view. In studying ore deposits there are four or more variables to consider, so that it is almost, if not quite impossible, to express all the features of all ore deposits in a single classification.

In order to place a deposit in its proper class, much detailed study is usually required and even then it may be impossible to secure indisputable evidence which will enable the geologist to properly classify the deposit. Therefore the origin of many known deposits is still in doubt and geologists are constantly changing their views regarding the genesis of certain ore bodies as new evidence is brought to light. Therefore it may happen that after a certain origin has

been assigned to a new and puzzling ore deposit, later it may be necessary to somewhat modify one's views regarding its genesis as additional data becomes available; because it is often the case that in the early stages of development of an ore body there is an almost complete lack of convincing evidence concerning its origin.

In order to understand the more or less complex processes which operate in the formation of ore deposits, it is necessary to consider first something of the nature of the rocks in which these deposits occur, and the formation of cavities in these rocks in which the ore minerals may be deposited.

ZONES OF THE EARTH'S CRUST.

Van Hise* suggests that the earth's crust may be divided into three zones: (1) an upper zone of fracture, beginning at the surface and extending downward to (2) the zone of combined fracture and flowage, which is underlaind by (3) zone of rock flowage, or no fracture. We know that there are stresses within the earth which are constantly exerting forces in many directions and the intensity and direction of these forces are forever changing. The rocks themselves offer great resistance to the forces tending to deform them, but when the force of their resistance is no longer sufficient to withstand the opposing force or set of forces, equilibrium is destroyed and a readjustment must follow. This readjustment usually takes the form of some movement or deformation in the rocks and may be apparent at the surface by folding or faulting or earthquakes. The position in the earth's crust at which these strains are acting will determine largely the nature and amount of deformation that may occur. For example, in the zone of rock flowage (zone 3) which is at great depth, the pressure of the superincumbent material would be so great that no fracture could remain open there, no matter how small. This is not difficult to conceive when we remember that it has been actually demonstrated that under conditions of sufficient heat and pressure the strongest rocks are made to flow like plastic bodies. Therefore, should a fissure be produced in the zone of flowage it would be immediately sealed again; and it follows from this that the zone of flowage must be composed of tight, non-porous rock which is quite impervious to waters and gases and therefore cannot be looked to as the seat of deposits formed from circulating solutions. The depth of this zone of flowage below the surface will vary greatly for the different rocks. An exact measurement is obviously impossible, but it has been estimated that at a depth of about one mile the pressure would be so great that shale will crush, and flow, while at a depth of five miles the hardest granite would be rendered plastic.

In the zone of combined fracture and flowage there will be some openings in the rocks. In this region the hardest and strongest rocks such as granite and gneiss, would be fractured by the great forces acting upon them, while if a fissure were to form in the less resistant rocks such as shale and limestone, it would be immediately sealed up again, due to the fact that at this depth the crushing strength of the shale and limestone is not sufficient to resist the tremendous pressure of the overlying material. Thus it is that in the zone of combined fracture and flowage certain ore deposits may form, but these are of a class comparatively rare and they usually show properties which are characteristic of a deep seated origin.

The zone of fracture is that one extending from the surface downward to a depth varying from a few thousand feet in the case of the softer rocks, to ten or perhaps fifteen thousand feet for granites and gneisses. In this zone the great majority of the ore deposits are formed, and by far the most of them are deposited within a mile or two of the surface.

It is not necessary, however, to have an open cavity or fissure existing within the rocks in order to have a deposition of ore either from magmatic or meteoric waters. Watery solutions, especially if they be hot and under pressure, have the power to actually dissolve their way through the rocks, replacing the original rock minerals by new ones as they go. This replacement of minerals by others is known as metasomatic replacement, and there is no doubt that many ore bodies have been deposited in this way. This replacement process is especially active in the more soluble rocks. While no one will dispute the importance of metasomatism in the genesis of ore depoists, the majority of ore bodies are probably deposited in open cavities of some kind. Therefore, in order to more clearly understand the processes of ore deposition under these conditions, it is desirable to study rock cavities, and the conditions under which they are formed.

ROCK CAVITIES AND CIRCULATION.

Rock cavities may be classified (1) with respect to origin; (2) with respect to size or (3) with respect to location. With respect to its origin, a cavity may have been formed either (1) by solution or by (2) fracturing.

A classification according to size would be as follows:

1. Super-capillary openings.
2. Capillary openings.
3. Sub-capillary openings.

In super-capillary openings the water which circulates through them will obey the laws of hydrostatics. In capillary openings, capillary action will control the movements of the solutions, while in sub-capillary openings, the cavities are so minute that the water remains in the rock but will not circulate through it. Very few if any ores would be deposited in these minute pores of the rock, and only a comparatively few are found in openings of the second class. Most ore deposits are formed by precipitation from solutions obeying the laws of hydrostatics in super-capillary openings.

Considering openings with respect to their location in the rocks, there are a number of classes, the most important of which are the following:

I. Primary openings.
 (a) Spaces between bedding planes.
 (b) Intergranular spaces — especially in the clastic rocks.
 (c) Vescicular spaces—ingneous rocks, especially in lavas.

II. Secondary openings (most important as channels for mineral bearing solutions.)
 (a) Solution cavities—caves, chambers, sinks, etc.
 (b) Cavities due to mass movement such as shrinkage cracks, joints, fissures, fault planes, etc., etc.

The waters which circulate through the rocks always contain in solution minerals, acids or gases, or all three, and their power to dissolve the rocks is thus greatly increased. This will be especially true if the solutions are under heat and pressure, as they usually are when at considerable depth. It will be readily understood how such a solution entering a minute crack in the rocks would be slowly forced along this opening, gradually widening the fissure as it went, by taking small amounts of the wall rocks into solution and carrying it away. This action will of course proceed most rapidly in the more soluble rocks, so we find that solution cavities reach their greatest development in limestones. Many of the "chamber deposits" and "cave deposits" in limestones have been formed in this way. They were originally small fissures which were widened, and perhaps lengthened, by solution of the walls, and which subsequently became filled with ore. The importance of the solvent power of acidulated water can be more readily understood after studying some of the great cave openings in the rocks produced in this manner. The Mammoth Cave of Kentucky was doubtless produced by the solution and removal of the limestone in which it occurs and it has been estimated that 12,000,000 cubic yards of rock have been removed in its formation.

Cavities due to fracturing may be pro-

*Treatise on Metamorphism. Monograph ..LVII, U. S. G. S. 1905, p. 1005.

duced in four ways: (1) by shrinkage of the rock masses; (2) by folding; (3) by faulting; (4) by earthquakes. Secondary fracture cavities are the commonest location of ore deposits because they occur in all kinds of rocks and in countless numbers. Primary openings are also of great importance in the formation of ore deposits, for they make it possible for the solutions to circulate through the rocks between the secondary openings. But the primary openings are only rarely the home of the deposits themselves. The copper bearing amygdaloids of the Lake Superior region is a good example of ore filling primary vesicular spaces in igneous rocks.

DEPOSITS FROM SOLUTION.

Solutions of one kind or another probably play some part in the formation of all ore bodies, but under this broad heading will be considered only those which owe their origin entirely or in the greater part to solutions circulating through openings in the rocks. This includes fissure veins of variable shape and size, stockworks, replacement deposits (in part), chamber deposits, etc. Types such as contact magmatic segregations, etc., which are not clearly related to openings in rocks, are not included under this heading, and will be considered separately later.

It has already been stated that the ultimate source of the metals is the igneous rocks, and geologists are practically agreed on this. But when it is attempted to explain how these metals were brought to their present resting place, complex problems are met with which have yet to be solved. That circulating solutions constitute the chief factor in transporting mineral matter from one place in the earth's crust to another is pretty well established. The difficulty lies in determining the source of these solutions and in tracing their movements through the rocks. One class of writers believes that the chief source of this water is the atmosphere and surface of the earth, and hence they agree that ores are deposited chiefly by these meteoric waters. Others maintain that the ore-bearing waters are primarily of magmatic origin, and are brought up from below with rock magmas. A third class, and this probably includes the majority of students of ore deposits at the present time, believes that both meteoric and magmatic waters have been active as agents in the concentration of most ores. The first concentration of the minerals, it is now thought, was in the majority of cases due chiefly to ascending hot waters. Later these magmatic waters may have come in contact with cold meteoric waters descending from the surface, thus causing a precipitation of mineral matter; or the minerals first deposited by magmatic waters may later have been subjected to the action of oxygenated meteoric waters and reconcentrated. These processes will be discussed more in detail under secondary enrichment.

Disregarding for the present those deposits which are clearly due in part at least, to agencies other than circulating waters, such as segregations from molten magmas, pegmatites, fumarolic and contact metamorphic deposits, there is a large group of ore deposits which doubtless owe their origin to deposition from solution. This class includes the commonest type of mineral deposits, i. e., fissure veins, and most deposits in secondary openings. The deepest mine shaft in the world is down only a little over one mile, and so our knowledge of the earth is exceedingly unsatisfactory.

The theories regarding the formation of ores of the deep zone must usually be based upon what little evidence remains at the present surface. Processes of denudation are constantly at work lowering the surface of the earth, rendering the rocks more porous, and providing channels for the circulation of surface waters. Thus it is that a deposit of ore which may at one time have been buried beneath a mile or even several miles of rock, may now outcrop at the surface. In the case of some of the older geologic formations, it is by no means improbable that even greater thicknesses of rock than this have been removed by erosion. Rain water falling upon the surface of the earth is disposed of in three ways. (1) A part of it runs off the surface into streams and is returned to the seas and oceans; (2) a second portion is returned by evaporation; (3) a third portion (and this is the part that plays the most important role in mineralization), seeps into the ground and into the underlying rocks. Of this water which sinks into the ground, a small portion is held near the surface by capillarity, but the great bulk of it permeates the pores and intergranular spaces of the rocks and forms the great body of subterranean water known as the ground water. The surface of this ground water is called the water table, or the ground water level. This water table is not a flat surface, but broadly speaking, follows the curves of the surface topography. For example, beneath a hill the ground water level will rise; and beneath a valley it will sink. It must be understood, however, that these are only general laws and under certain modifying circumstances exceptions may be noted, as, for instance, a persistent stratum of impervious material, such as clay or shale, may dam back the ground water and cause an unnatural distoration of the water table.

Where such a condition obtains, the water will be under greater hydrostatic pressure and may be forced to the surface to form springs, or it may be diverted in any direction until released from the pressure of its confining walls, when it will once more tend to return to its normal position. The great bulk of this underground water is probably of meteoric origin, although it is impossible to conceive of any condition which would prevent magmatic waters from mixing with this surface water in any proportion should such magmatic water be encountered. That such additions of magmatic waters are constantly being received by the ground water is almost certain.

If we accept the hypothesis of the three zones of the earth's crust, it is seen at once that there is a limit in depth to which this ground water can descend. It certainly permeates the zone of fracture; part of it may even get down into the zone of combined fracture and flowage; but it is quite certain that none of it could circulate in the zone of flowage. As the ground water travels deeper and deeper into the rocks, temperature is constantly increasing. The amount of this increase, so far as we know, is on the average about one degree Fahrenheit for every sixty feet in depth. Furthermore, as it descends, the pressure on the water becomes greater and greater.

Both increase of temperature and pressure are favorable to the solution of mineral matter, and hence the solvent power of the water is constantly increasing as it descends. But at a certain depth which varies with the local conditions, the impermeability of the rocks will become so great that these waters can no longer penetrate them, and they will be forced to spread out laterally and finally rise, due to hydrostatic pressure. During their progress downwards, certain acids and alkalies would be taken into solution, so that by the time these waters reach the lower limit of their journey, the solutions would be capable of dissolving almost any of the metallic minerals which they might encounter. As the solutions rise, it is natural that they should tend to follow the more open fissures and channels in the rocks.

The temperature and pressure are now decreasing and the solutions which may be already supersaturated now would begin to drop part of their load and precipitation would start. Since the upward circulation is mainly along the larger fissures or openings, it follows that the greatest deposition of mineral matter would be along the walls of these trunk channels. Such is probably the case, and it is likely that many filled fissures have originated in this way. Another factor

favoring the deposition of minerals along the trunk channels is the fact that the meteoric waters would be almost sure to mingle with water of magmatic origin in these larger openings, and this mingling of solutions of different chemical composition would result in a precipitation of certain compounds along the walls of the fracture. Chemical reactions between the solutions and the wall rock is another potent factor in the first concentration of ores.

As stated before, there is no doubt that certain ores owe their concentration to the action of circulating meteoric waters, but any theory that attempts to explain the origin of the majority of deposits, or even the majority of veins, by this method, must meet with strong objections. The chief of these objections is the fact that meteoric waters do not circulate through a sufficiently extensive zone to accumulate the tremendous quantity of metallic minerals found in many deposits. These waters may circulate throughout the zone of fracture, but it is probable that they seldom reach a depth greater than 2,000 feet, and then it is only when they have followed open fissures in the rocks.

The theory of concentration of ores by magmatic, or juvenile waters was first suggested by Elie de Beaumont* in 1850. Since then the theory has rapidly been expanded, and as a result of the observations made during the last half century, many of the leading students of ore deposits of the present time emphasize the importance of magmatic solutions in the genesis of ores. The most important observations indicating the agency of magmatic waters in ore concentration are:

(1) Igneous magmas contain considerable quantities of water. This is evidenced by: (a) the vast quantities of steam given off from volcanoes; (b) by the experiments of Daubray, who showed that molten granite contains much water vapor which it gives off on rising toward the surface; (c) by the water in igneous rocks, such as obsidian and the natural glasses; (d) by mariolitic cavities in deep seated rocks; (e) by vescicular spaces in volcanic rocks, like pumice, etc.; (f) by water bubbles in quartz; and (g) by contact metamorphic phenomena which indicate the presence of hot waters at the time igneous rock which produced the metamorphism was intruded.

(2) The almost universal association of metalliferous veins and igneous rocks. This is extremely suggestive. Even where the veins themselves show no evidence pointing toward a magmatic origin, the fact that the veins are all close to igneous intrusives (as they are in many districts) and entirely absent when away from the intrusives, is a strong argument for a genetic relationship between the two. This association is especially striking in the case of the gold and copper deposits of North America. Lindgren† has shown that the periods of gold vein formation agree closely with the periods of igneous activity.

(3) When rocks are intruded by igneous magmas they are shattered and fissured and thus pathways are created for the circulation of mineral solutions which usually follow the magma.

This is a very important consideration for in this way openings are prepared for the deposition of the ores which otherwise might not be concentrated in a sufficiently small volume to result in deposits of workable value.

(4) In areas adjoining igneous rocks the conditions would be most favorable for the deposition of minerals requiring the action of hot ascending solutions and vapors. The solutions may be meteoric and be heated by contact with the igneous rocks, but even so, it is probable that they would mingle with magmatic waters in some proportion where the trunk channels of circulation are along or near to the igneous contacts.

(5) The bottom levels of some deep mines are quite dry and dusty. This suggests that the ores may have been deposited by magmatic waters at some time in the past and then the solutions became exhausted or the locality was shut off from the source of the mineralizing agents.

(6) Ores have been concentrated below the lower level of ground water. While it is true that the level of ground water is changing more or less all the time, yet the presence of ores far below the limit of the ground water circulation is more readily explained by the magmatic water theory than by any theory involving complex structural or topographic changes to produce a great diminishment in depth of the ground water zone.

MAGMATIC SEGREGATIONS.

The concentration of certain minerals into zones or masses within a magma during the process of cooling is known as magmatic segregation or magmatic differentiation, and when these minerals are of a metallic nature, ore deposits of this type may be formed. During the cooling of a magma the first elements to separate from the parent mass will be the heavier and more basic ones, such as magnetite, pyrrhotite, etc. If we think of the magma as an igneous rock in a liquid condition, this segregation process may be more clearly understood. The mass is restrained from total and immediate crystallization by its high temperature and the great pressure upon it. Gradually, as these become diminished, the various minerals will solidify out of the mass. The first crystal to form will tend to segregate in the still liquid mass.

Perhaps the most direct agent operating to form ore deposits of this type is gravity, by means of which the heavier part of the mixture sinks to the bottom. Convection currents within the mass also have an important influence in this process of differentiation. It is not necessary that the crystals be formed before segreation may begin. The separation of the heavier and more metallic portion of the mass may take place before crystallization begins, as slag is separated from matte in the furnace. As the solidification of the mass nears completion, there would be left a fluid residue consisting chiefly of an aqueous solution rich in silica; the highly mobile elements such as fluorine, boron and chlorine; and many metals in varying amount.

Ore deposits of the magmatic segregation type are necessarily found only in igneous rocks, which have crystallized slowly, and which are usually of the more basic varieties, such as peridotite, gabbro, norite, diabase, etc. The minerals of these deposits are those characteristic of igneous rocks such as magnetite, pyrrhotite, apatite, cassiterite, corundum, ilmenite, titanite, tourmaline, topaz, emery quartz, feldspar, muscovite, biotite and many others. The metals which are obtained from deposits of this class are iron, nickel, titanium and some copper. The gangue minerals are chiefly quartz, feldspar, pyroxene and mica. An important feature of magmatic segregations is the fact that the minerals composing the country rock are the same as those of the ore deposit, but the proportions are different.

In size the deposits are extremely variable. Some are very large; others small. They are also variable in shape, and in general are quite irregular as to outline. Many are ellipsoidal, while others occur around the periphery of the parent rock. One of the chief characteristics is the intergrowth of the ore minerals. There is an almost complete absence of crustification. The ore often grades into the country rock rather abruptly.

PEGMATITES, OR PEGMATITE VEINS.

Siliceous igneous rocks, especially those rich in potash, often contain pegmatites or pegmatite veins. As these rocks cooled at great depth, the end-products of crystallization, i. e., the more soluble portions of the magma, may have segregated to form veins or tabular masses in the fissures and cracks which were produced in the already solidified portion of the magma. In some cases the

*Bull. IV, Geol. Soc. France, p. 1249.

†Lindgren: Metallogenetic Epochs, Econ. Geol. IV, 1909, p. 409; also Trans. A. I. M. E. Vol. 33, 1903, p. 790.

pegmatitic material may have forced itself into the surrounding rock, making the opening while it filled it.

The association of pegmatites only with rocks of the granitic type has led some writers to use the name "granite juice" for the last portion of the magma to solidify. These end products are more mobile than the parent magma because they contain an excess of steam and other gases. Elements such as fluorine, boron, chlorine, etc., are known as "mineralizers," are also present in the pegmatitic material in considerable amount, and these further increase the mobility of the magma. Therefore, if fissures are formed in the portions of the original magma already cooled and solidified, or in the country rock bordering the granite mass, the pegmatitic material would be injected into them by reason of its liquid condition.

Rhyolites, quartz-porphyries and surface lavas in general never yield pegmatites. For that reason it is believed that great pressure is necessary for their formation, and this condition would naturally exist only in the deep seated rocks. The fissures into which the pegmatites were injected were probably not connected with the surface, for had they been thus connected it is probable that the mineralizers would have escaped. Some deep seated rocks, even those acidic ones rich in potash, are entirely free from pegmatites. This may be due to the fact that avenues existed along which the mineralizers made their escape.

The processes by which pegmatites are formed have been compared to the formation of eutectics in alloys. It is known that certain definite mixtures of some compounds will remain liquid at a lower temperature than any other mixture of the same compound. Furthermore, if the original mixture is in some other proportion than the "eutectic ratio," then the compound of which an excess exists will crystallize first until the remaining mixture has the eutectic composition. This seems to be exactly what happens in the formation of pegmatites.

The minerals found in pegmatites are essentially those of igneous rocks. This of course follows from the fact that pegmatites are essentially those of the igneous rocks. This of course follows from the fact that pegmatites are themselves phases of an igneous rock generally of a granitic type. Orthoclase (potash feldspar) is the most abundant mineral in many pegmatites. Quartz and mica are next in abundance, and these three minerals usually constitute nearly the entire mass of the rock. In general the composition is much less variable than the composition of the igneous rocks. Some varieties of pegmatite consist almost entirely of quartz and orthoclase. The metals contained in pegmatites in workable amount are few, the chief of which are gold; iron (as ilmenite); and tin (as cassiterite). In many instances, the pegmatites grade into quartz veins, which may or may not be gold bearing. The principal minerals of economic value occurring in deposits of the pegmatitic type are the rare gem minerals, such as tourmaline, beryl, rutile, garnet, topaz, kunzite, aquamarine, rubelite, spodumene, etc. Feldspar; quartz and mica of commerce are also obtained almost entirely from pegmatites.

In shape the pegmatites are usually tabular although where they occur entirely within the parent rock they may be quite irregular as to outline. Where they intrude sedimentary rocks, which is comparatively rare, they generally follow the bedding, or planes of schistosity. The deposits vary greatly in size. Sometimes the injected pegmatite sheets are almost paper thin, especially in highly schistose rocks. Again they may be many feet thick and cover acres.

The internal structure of the deposits is characteristic. The crystals are usually large and well developed and are commonly intergrown. The variety consisting of an intergrotwh of quartz and orthoclase often presents a peculiar graphic texture, and the rock has been called "graphic granite." Ather varieties containing unusually large crystals of these minerals with mica have been called "giant granite." Sometimes the contact between the wall rock and the pegmatite vein is gradational. Cavities are common and these are often lined with crystals of the rarer minerals. The choicest gem minerals obtained from pegmatites usually come from these cavities. Banded and comb structure is not unknown, but this feature is less common than in true veins. Crustified druses are also developed.

Contact metamorphism has been noted in a number of cases where pegmatites cut sedimentary rocks, but this is usually not intense.

Numerous examples of pegmatites occur in the Appalachian states, where they constitute the chief source of the domestic feldspar, quartz, and mica of commerce. In Maine and in Southern California, many gems, chiefly tourmaline, are obtained from pegmatite veins. In Canada, they furnish the mica of commerce. The monzonite, which is mined from placers, chiefly in the southern Appalachians, comes primarily from the weathering of pegmatite veins. Before the development of the high grade deposits of phosphate rock in the United States, the main supply of mineral fertilizers came from the apetite deposits of Ontario, Canada, where it occurs in pegmatites. Other mineral deposits of economic value are mined from pegmatites, among which are molybdenite, titanium, cassiterite and magnetite. Closely related to pegmatites, is a type of deposit formed by eruptive after action by the combined agency of gases and water. As a magma cools and starts to crystallize, the first portion to consolidate will be the upper and outer surface of the mass. The pressure exerted by the still molten mass within will cause fractures to form in this thin crust, through which the hot gases and vapors can escape. These vapors and the watery solutions which accompany them are doubtless rich in mineralizers such as fluorine, boron and chlorine, and contain dissolved in them most of the precious metals which may have been in the original magma. As these solutions rise through the various fissures and the fracture planes in the rock they may deposit certain minerals such as fluospar, apatite, and the minerals common in pegmatites.

CONTACT METAMORPHIC DEPOSITS.

Contact metamorphism is a term applied to certain characteristic changes which are brought about when igneous rocks intrude certain sedimentary ones; and when metallic minerals are concentrated within this zone of alteration by the same general processes which produced the alteration, the deposits are called contact metamorphic deposits. Contact metamorphism is not produced by extrusive rocks, like basalts, and the glassy rhyolites and andesites. The rocks which produce the typical contact metamorphic changes are usually diorites, monzonites, and granites, and the deep seated porphyries. The changes produced are caused by the solutions and gases from the intruding mass.

The most characteristic alteration is found in soluble rocks such as limestones. Here the lime carbonate is usually converted into a mass composed of calcite, garnet, actinolite, epidote, tremolite, diopside, magnetite, specularite and other minerals. If the original sedimentary is of a shaly character, aluminum rich minerals, such as andalusite and sillimanite are well developed.

The watery vapors given off by the intrusive are perhaps heated above the critical temperature (365 degrees C.) and they are under considerable pressure. Furthermore some of them contain compounds of boron, fluorine and chlorine which are capable of combining with certain metals and silica to form highly volatile compounds. These gases and solutions, together with the steam generated, are forced into the pores and spaces in the intruded rock, and permeate the mass along the contact with the intrusive. The minerals of the sedimentary are replaced by new ones. There is a more or less complete recrystallization

of the sedimentary rock. New material may be introduced by the hot solutions, or there may be only a rearrangement of the elements in the original rock to form different compounds. In general large amounts of CO_2 are removed from the limestone, but this loss is compensated for by the addition of silica, iron and small amounts of boron, fluorine and chlorine compounds. Varying amounts of the valuable metals such as copper, gold and silver, may also be introduced by the intruding magmas. Garnet is perhaps the most characteristic of the contact metamorphic minerals, and in some instances shaly limestones have been altered to masses consisting almost entirely of garnet. Where igneous rocks are intruded by other igneous rocks, garnets are very rarely developed. However, other contact metamorphic minerals may be developed along the contact of the two igneous rocks.

The distance from the intrusive to which the contact metamorphism extends is seldom more than 2,000 feet and usually much less. Vogt cites examples, however, where contact metamorphism is apparent as far as a mile from the intrusive. The ore bodies, if any are developed, are usually close to the contact where the changes are most intense.

The typical ore of contact metamorphic deposits is a garnet-sulphide ore of copper. In general the deposits are low grade and are only rendered workable after rocesses of recondary enrichment have taken place. However, there are some large deposits being worked for the primary ore. The ore is often a mixture of the heavy silicates intergrown with sulphides and oxides of the metals. The chief metals mined from contact metamorphic deposits are copper, iron and gold with a little lead and zinc. The deposits are very irregular in shape and detail and in this respect bear no resemblance to veins. They are seldom if ever tabular, but are often broken up and disconnected and localized. They rarely have definite boundaries and the ore is merely an enriched portion of the country rock. In size, they are also extremely variable. Some deposits have yielded hundreds of thousands of tons. The ore is usually low grade and is often difficult to concentrate because of the high per cent of heavy minerals in the gangue. The sulphides are usually segregated in irregular bunches and masses throughout the zone of contact metamorphism. The gangue minerals (chiefly silicates) are often intergrown with the ore minerals. Crustification is never present in ores of this type.

Ore bodies of other types are often associated with contact metamorphic deposits. These may be veins, disseminations or replacement deposits and they may be of the same age as the contact metamorphic deposits. Acidic igneous intrusions do not always cause contact metamorphism of the sediments, and when this alteration is brought about accompanied by a concentration of ore minerals, a second concentration by descending waters is generally necessary before deposits of workable value result. Examples of contact metamorphism may be seen in the Clifton-Morenci District, Arizona; Marysville, Mont.; Coeur D'Alene, Idaho; Cananea, Mex.; and many other places.

SECONDARY ENRICHMENT PHENOMENA.

Most large and rich ore bodies owe their economic value to secondary enrichment by descending oxidizing waters. Primary deposits, in their first concentration, are not often rich in the metals, although notable exceptions are known. Most ore bodies contain rich belts, or shoots, which are formed by the addition of the metallic content of some other portion of the deposit to these local zones. This action is due essentially to the leaching of the upper oxidized and soluble portions of the deposit by cold descending oxygen bearing waters; and the deposition of the metals from these solutions as they reach the lower portion of the deposit and lose their acidity or meet with the primary sulphides.

An ore deposit may be divided into four theoretical vertical zones. These are:

1. Leached zone near outcrop. As the minerals in the deposit become weathered and oxidized, the primary compounds break down to form more soluble compounds. These are attacked by cold acid waters and the metals are carried downward in solution, leaving a lean or barren leached outcrop, or gossan, at the surface, which is often stained brown by the presence of limonite which remains behind on account of its relative insolubility.

2. Zone of oxidized minerals. Below the leached outcrop is a zone containing many of the oxidation products of the sulphides which have not yet been leached by the descending waters. Oxides, carbonates, sulphates and native metals predominate here. Many of these are deposited by the solutions from above, while others are direct alteration products of the primary sulphides. These are mixed with some unaltered sulphides. Both zone 1 and 2 are found above the ground water level.

3. Zone of enriched sulphides. Beginning at the level of ground water, and extending downward for a variable depth, the mineral composition of the deposit undergoes a marked change. Whereas the minerals above the ground water level are chiefly oxidized products, below this level the sulphides predominate. As the oxidized solutions enter this region, they encounter some of the primary sulphides which have been protected from the oxidizing action of air. If these solutions carry compounds such as sulphates, chlorides, carbonates, etc., when they encounter the sulphides of the base metals such as pyrite or blende, a reaction will occur, resulting in a precipitation of the metals from above in the form of secondary sulphides.

4. Zone of primary sulphides. Toward the lower limit of the zone of enriched sulphides these secondary minerals become less abundant and finally pass into the primary sulphides which continue to indefinite depth, or to the lower limit of the deposit.

It is well known that the primary metallic minerals are usually deposited as sulphides, antimonides, or arsenides. In the case of the precious metals, the gold and silver is usually deposited with some primary sulphide of the base metals, to form minerals such as auriferous pyrite, or argentiferous galena. Pyrite or marcasite is a common associate of nearly all ores of copper, lead, and zinc, and they play a most important role in the secondary alteration of the deposits. As weathering proceeds at the surface of these deposits, the pyrite breaks down to form ferric sulphate, ferrous sulphate, and sulphuric acid. The sulphuric acid attacks the sulphides of the deposits and converts them into sulphates, which are as a rule soluble. Descending surface waters now take the sulphates in solution and carry them down until they encounter primary sulphides where the metals are precipitated as secondary sulphides. The depth below the surface at which the secondary sulphides form depends upon the depth of the ground water, the permeability of the lode, the climate, topography, and other agencies.

Another very important factor upon which the amount of enrichment depends is the time element. It would be natural to suppose that in general, Cretaceous deposits will be more greatly altered than Tertiary deposits. This, however, is not always true. Brittle mineral deposits are usually altered to greater depths than are those in which the minerals are tough. This is because the fractures and cracks which readily form near the surface in brittle rocks favor the circulation of descending waters, and the oxidized minerals are more rapidly dissolved. Contact metamorphic deposits usually contain a large per cent of non-brittle silicates. This may be the reason why contact metamorphic deposits seldom show deep secondary alteration.

Metalliferous minerals as a rule weather more rapidly than the common rock forming minerals. This results in

an alteration of the ore body to a greater depth than the country rock. In regions where the climate is warm and moist the alteration processes proceed rapidly; where the erosion of the surface is rapid, there is usually but slight sulphide enrichment, for the secondary minerals are removed almost as soon as they are formed. In such localities the primary ore is apt to be close to the surface. This is well shown in the veins in the high altitudes of the Rocky Mountains, where primary ore is often found at the outcrop. In arid regions of flat topography denudation lags behind alteration and alteration extends to considerable depth. In some cases the oxidized zone may extend to 800 or 1,000 feet below the surface. As weathering and erosion proceed, there may be a repeated migration of the metals downward, resulting in a complete rearrangement of the horizontal sequence of the minerals of the deposit. Different minerals vary in solubility and this results in a final arrangement of the metals into zones according to their relative solubilities.

Most deposits contain two or more metals and often several of these are present in sufficient quantity to render their extraction profitable. The combination of minerals found in any one deposit will vary greatly, but certain associations are characteristic. Primary minerals of iron, lead and zinc are often found together, as well as iron and copper; silver and lead; and gold and silver. In the first combination, these primary minerals are probably uniformly mixed throughout the deposit. But after secondary alteration processes have been operative, there is a well defined segregation of the different metals into vertical zones. For example: in a deposit of zinc, iron and lead sulphides, the lead will be concentrated nearest the surface because it is the least soluble and will be precipitated by the first reducing agent with which the descending surface solutions come in contact.

COPPER ENRICHMENT.

The primary ore of copper is usually chalcopyrite ($CuFeS_2$). This is attached by the H_2SO_4 in the oxidized zone and the copper converted into copper sulphate ($CuSO_4$). In nearly all of the copper districts where the deposits show secondary sulphide enrichment, the metal was probably carried down in solution in the form of the sulphate, and was precipitated either as chalcocite, or bornite, by some primary sulphide of the metals. Covellite is probably acted upon by $CuSO_4$ to form chalcocite but the exact reaction is unknown. Chalcocite is the great ore mineral of many copper deposits, and usually constitutes the most valuable constituent in the bonanza zone of secondary sulphides. Associated with the primary chalcopyrite are usually some other sulphides such as pyrrhotite, blende, or pyrite. If the deposit contains primary chalcopyrite and pyrite, chalcocite may be formed directly according to this equation:

$5FeS_2+14CuSO_4+12H_2O= 7Cu_2S$ (chalcocite) $+5FeSO_4+12H_2SO_4$

An important factor influencing the depth of secondary enrichment is the permeability of the lode. Where the rocks are tight and relatively impervious, the descending sulphate solutions cannot travel as far as they can where there are free channels of circulation. Again, sealed faults, gouge seams, etc., may dam back these waters and confine the zone of secondary sulphides to shallow depths.

When pyrite reacts with the sulphates, sulphuric acid is always produced and may attack the wall rock, producing kaolin, gypsum, talc, chlorite, etc., depending upon the composition of the wall rock. Therefore these gangue minerals are characteristic of the zone of secondary enrichment and not of the primary ore.

LEAD-ZINC OCCURRENCE.

Secondary processes operating upon deposits containing these two metals always result in a more or less complete separation of the two metals in the upper zone of secondary alteration . Below, in the primary ore, the minerals of the two metals will be mixed in the original proportions.

The only primary zinc ore of importance is sphalerite (ZnS). The two most important secondary ores of zinc are smithsonite ($ZnCO_3$), and calamine ($Zn_2H_2SiO_5$). In the limestone regions, zinc enrichment has often been produced on a large scale, as in the upper Mississippi valley deposits, and in Southwestern Missouri.

In the Upper Missippi Valley deposits, the lead and zinc minerals are associated with marcasite, pyrite, and some chalcopyrite.

They occur in limestone underlain by a carbonaceous shale called "oil rock." Above the level of ground water, lead minerals predominate. Galena, cerussite and anglesite are the chief ore minerals here. Associated with these is some sphalerite and smithsonite. Below the level of ground water sphalerite is the chief mineral, and the oxidized products are entirely absent. This separation of zinc from a primary mixture of lead and zinc is due to the relative solubilities of the minerals of the two metals. Not one ore mineral of lead is very soluble, while the common zinc minerals are quite soluble. Therefore zinc is seldom carried far by secondary processes, and if secondary lead is produced it usually consists of the oxidized minerals and occurs relatively near the surface.

SILVER ENRICHMENT.

The primary ores of silver are chiefly argentite minerals and silver bearing sulphides of the base metals, such as argentiferous lead, zinc, and copper minerals often containing arsenic or antimony. The only salt of silver which is very soluble is the nitrate, but nitrates are uncommon in mine waters. Several salts of silver are somewhat soluble. Silver chloride ($AgCl$) and silver sulphate (Ag_2SO_4) are dissolved to some extent in mine awters.

The rich silver minerals are usually found in the upper levels of mines. The most important are ceragyrite, argentite, proustite, stephanite, and native silver. At greater depth, these disappear almost entirely giving place to the primary argentiferous sulphides of lead, zinc, or copper. The processes of silver enrichment are essentially similar to those operating upon minerals of the base metals. This follows from the fact that most of the silver supply of the world comes from silver-lead, silver-gold, silver-cobalt, or silver-copper ores. The silver minerals are usually the least soluble of all those in the deposit and are therefore concentrated in the upper levels. The chief secondary ores are the oxidized products and secondary argentite, (Ag_2S). The argentite is usually precipitated from oxidized solutions before the sulphides of the base metals because of the strong affinity of silver for sulphur. Therefore, the first sulphide encountered by descending silver-bearing solutions will usually precipitate secondary argentite.

SECONDARY ALTERATION OF GOLD ORES.

Gold occurs native or as a telluride, but the most common occurrence is probably as auriferous pyrite. Gold is relatively insoluble in its native state, but as a chloride or iodide it is quite soluble. It is also soluble in ferric sulphate and somewhat soluble in hot alkaline solutions. Gold is precipitated readily by ferrous sulphate and by organic matter. The precipitation usually takes place as native gold intimately associated with the sulphides of the base metals.

Most gold deposits are richer in their upper levels. This is probably due to "residual concentration," i. e., the weathering of the country rock and the removal of the more soluble minerals leaving the residual gold behind. There is no addition of material in this process but the result is the same, inasmuch as it increases the amount of the precious metal in a given mass of the rock. Portions of this gold may be dissolved and carried

to lower levels. Dr. W. H. Emmons* in a paper treating the enrichment of the gold deposits of the United States, shows that the secondary enrichment of gold by descending surface waters depends largely upon the presence or absence of manganese in the deposit. The strongest solvent for gold is nascent chlorine, but nascent chlorine is produced in mineral waters only under certain conditions. In concentrated acid solutions, under heat and pressure, chlorine may be produced from NaCl by the ic salts of iron and copper. But mine waters are cold and dilute, and this action probably cannot take place under such conditions. It is here that the manganese plays its part in gold enrichment, for MnO_2 can release nascent chlorine from NaCl and HCl in cold dilute solutions. The reactions are probably as follows:

(1) $MnO_2+2NaCl + 3H_2SO_4 = 2H_2O+2NaHSO_4+2Cl$.

(2) $MnO_2+4HCl=2H_2O+MnCl_2+Cl_2$.

The nascent chlorine thus liberated is free to convert the gold into the chloride which is thus dissolved and carried down by the descending waters. The gold, in solution as the chloride is precipitated as native gold by ferrous sulphate, $FeSO_4$. Ferric sulphate $Fe_2(SO_4)_3$, does not precipitate gold. Both ferric sulphate and ferrous sulphate are produced by the oxidation of pyrite which accompanies nearly all gold deposits. Therefore it would seem that the gold in solution could not migrate far before it would be precipitated by the ous salt. This would certainly be the case if there were no manganese present. But manganese readily converts ferrous iron into ferric iron which does not precipitate gold. Thus the manganese plays a double role in the alteration of gold ores.

Gold deposits containing manganiferous gangues may be expected to show a greater downward migration of gold than will those deposits which are from manganese. It also follows that deposits which contain no manganese would be more likely to form placers than would manganiferous gold ores, for in the latter case the gold would be partially removed from the oxidized zone in solution.

The presence of manganese in the ore will not be sufficient to render all the gold soluble, and much of it may remain behind to enrich the outcrop. The outcrops of gold bearing quartz veins are often pitted or "honey-combed" by the disintegration of part of the quartz and the dissolving of the more soluble minerals which may be imbedded as small crystals in the quartz. Such outcrops are apt to be stained brown by the presence of iron oxide in the form of limonite, and if the deposit contains gold, much of this gold may remain in the honey-combed gossan, thus forming a body of bonanza ore close to the outcrop. The gold in such a deposit is often coated with a thin film of iron oxide, and is called "rusty gold." For that reason it may be difficult at first inspection to recognize its presence in the rock, although it may be there in considerable quantities.

While many gold ores have been enriched by the processes just outlined, yet, in many deposits, the gold content grows constantly smaller from the outcrop downward, and the value of the deposit will depend upon the quantity and richness of the primary sulphide present.

*W. H. Emmons: Manganese in the Secondary Enrichment of Gold Deposits of the United States. Bull. A. I. M. E., Oct. 1910.

The Ray Consolidated report, covering a period of eighteen months, is just out. It is much in the nature of an apology for all that the company has failed to accomplish, with accompanying promises for the future. We'll touch it up next month.

The following is a short accurate method for securing length for a belt. When it is not convenient or possible to measure with line the required amount of belt needed, add the diameter of the two pulleys together, divide the result by 2, and multiply the quotient by 3⅛. Add your product to twice the distance between the shafts carrying the pulleys, and the result is the length for belt.

The materials from which Portland cement is made contain calcium, silica and alumina. The raw materials also contain small quantities of iron and magnesia in some form. The materials are crushed and ground, mixed in proper proportions and burned at a high temperature to a hard clinker, which in turn is ground to a fine powder. Usually during the grinding of the clinker a small quantity of gypsum is added to retard the action of the cement and otherwise improve its quality.

The Powder House at Midnight

By CHAS. I. Duncan, Miami, Arizona

The power-house at midnight shows wondrous and wierd
By some conjuror's hand in the lone canyon reared;
The thunder-bolt's might and the hurricane's power,
Mechanically mastered, like angry beasts cower;
The forces, when free that meant death and disaster,
With a roar of pent rage here acknowledge man master.
Here great generators feed fire to the wires;
Here hum the compressors like titan touched lyres;
The silent condensor moves slow rolling gear;
And like wind on the water there comes to my ear
The mighty crescendo of shaft and of wheel,
The rhythmical cadence of steam driven steel;
The electrical mercury lights shimmer green,
From cross-heads reflecting their emerald sheen;
Beneath the steel girders the shadowy crane
Casts sable reflections from carriage and chain,
Majestic and sombre in vast vague of grey
It hovers above like a huge bird of prey;
Each motor in motion vast energy wakes,
Great arc lights glow splendid and force the world shakes,
Grim slumbering titans respond to the thrill
Transmitted for miles over canyon and hill.
At the engineer's touch like a mettlesome steed,
With firy endeavor at steel harness strains—
Who gives them the spur needs firm hand on the reins.
And while the world rushes to morn's golden glow,
The grim "grave yard" shift passes weary and slow:
Now the whistle's hoarse call greets the rise of the sun—
One shift has been finished, another begun.

Reminiscenses of Stampede for Gold in Nevada Boom

By CLARENCE E. EDDY.*

The name and fame of Goldfield, Nevada, has a lustre that will not soon fade. It is true that the period of sensational speculation is largely past, but development and production are infinitely greater than they were in the boom. The flow of golden wealth, however, is now confined to well-defined channels and does not disseminate with the effervescence of earlier days.

Goldfield today, with its splendid payroll and prosperous business and its mighty output of bullion, is one of the marvels of the western mining world, but the "good old days" when "a poor and honest man" could steal high grade at Goldfield, indeed are gone.

THE ROMANCE OF REALITY.

It is now more than ten years since the discovery of the South Nevada treasure fields marked the beginning of a new era in western mining. It was in fact the discovery of Tonopah by Jim Butler in 1901, that soon resulted in the discovery of Goldfield, and thence the discovery or revival of many a camp of the deserts—Manhattan, Bullfrog, Greenwater, Skidoo, Hornsilver, Seven Troughs, Rawhide, Jarbridge, Ubaheba and goodness knows what—all came from the fact that brave Jim Butler, with the aid of burros and a half-breed Indian, had first broken the silence by the discovery of the grizzled ores of Tonopah, in the midst of the mighty deserts.

A new era, indeed, had dawned in the western mining world. The old days when prospecting and mining had been followed mostly by hardy and adventurous pioneers—horny handed diggers and bewhiskered denizens of the woods and wastes—was now to make room for an infinitely larger influx of people of all stations and professions, and of all "races, sex, color and previous condition of servitude."

The eastern "counter jumper" and nondescript worker and also the society celebrity, millionaire, minister of the gospel, "saint and sinner"—all were to get the mining craze and come to the mighty deserts, as miners, speculators, promoters, business men—anything to get into the game in accordance with the best of their ability or such fortune as might fall to their lot.

People of varying means, from shore to shore of the continent and even from over the seas, began to hear and take notice of the great treasure discoveries in the western deserts.

Investments and enterprises were soon forthcoming from far and near. Every means of publicity was ultimately enlisted in the dissemination of the welcome news, that millions of metallic treasure were being unearthed in the deserts. The good news, from the mere fact that it was good news, if from no other reason, was set forth in publications almost everywhere. The newspapers, even the greater publications east and west, were soon spaced with column after column of accounts and illustrations and even the songs of poets—all in description and praise of the great triumph of the discovery of golden millions in the mighty deserts.

The west having been long a theme in our literature—in drama and song and story—because of its earlier days of gold, was now tremendously to the front, for the drama was to be re-enacted upon a larger scale.

The lingering, romantic conception was that to be in the west you must be "a westerner," in accordance with the approved models of the story books. A westerner was supposed to be a sort of a rugged matinee idol, dressed in unusual garb and adorned with "shooting-irons," and endowed with dramatic heroism. How could all the incoming easterners, from all stations and avocations attain their ideal in the new west? For a new west, after all, it was to be. They would come and try to be truly western in accordance with the ideals of the story books, but the result due to changing conditions, was that withal they could not be as romantic as they had hoped. They could not often find gold in glittering heaps as they had fancied. Many came and wore slouch hats and khaki and high laced boots, and carried "arsenals." But the majority, of course, came on the scene as best they could. The result was indeed a picturesque and impressive population in and about the fast-appearing camps. The eastern clerk had become a proud claim-owner, with unlimited hopes of fortune and at least a strenuous aim at being a true "hero of the west."

PREACHER BECOMES A PROMOTER.

The old prospectors had gathered in with "the real goods." The millionaire was there to see and report to his eastern financial associates. The eastern farmer had become transformed into a prospector, but had retained most of his eastern traits; grocerymen had become mine operators, and artists had become engineers, and preachers had become promoters, while eastern matrons had been transformed into proprietors of mining camp rooming houses and restaurants. The many transformations would take pages to define. Adventurers and adventurers—gamblers, courtesans, etc., had come from all quarters of the globe, with the determination to be wilder and more free than ever. As a new addition to the annals mines, resolved that they, too, would be adventurous and romantic—that they too would drain the cup of adventure in accordance with the way they had sometimes read and dreamed of it as existing in the merry whirl of the mines.

The result was a conglomeration of humanity, such as has seldom been brought together in the history of any boom. Money was interchanging, largely through confidence due to a lack of practical knowledge of the facts and possibilities of mining development. The general idea was that "gold is where you find it," and that anyone was liable to find it in almost unlimited quantities at any time under any big pile of stone or in any ravine or wash or hillside, and hence as it had really been found to exist in great and valuable quantities, at some place near by, and it was considered only a question of a little time and development until it would be further brought to light; that "one man could see just as far into the ground as another," and that digging and staying qualities, however directed, could be depended upon was also a great factor in the general idea of the backers and followers of the boom.

EXCITEMENT INCREASES.

A great, complex, picturesque, varied and intermingled mass of people, intoxicated by the thought and quest of fortune, were gathered upon the deserts. The craze was not limited to the small investor and the naturally venturesome, but substantial capitalists were staking

*"The Poet-Prospector," Bonanza, Idaho.

their carefully accumulated means upon the camps and their showings or indications of mineral. Railroads began building to make the fields more available and to avail themselves of the field's business. A mighty climax of industry was culminating upon the deserts. A drama, greater and more modern and really more romantic than ever before in the history of the west, was now upon the stage of events. Goldfield was the soul and radiating centre. Its mining locations had augmented, until they spread for miles upon miles in every direction, and of every name and shape and possible size. Some claimed only a fraction, others ignorant of the limitations of the statutes laid claim under single notices to the scope of a homestead. They were criss-crossed and often conflicting, but still claiming dips, spurs, angles, veins, leads, lodes, ledges, deposits, ramifications, millsites, townsites, damsites, etc.—anything to get to the front for a fortune.

Corporations and capitalizations were formed until laws and language was exhausted to the limit of their scope to describe and depict and define what the claimants and investors were undertaking. Shafts and tunnels and crosscuts—excavations and developments of all kinds—began to scar and transform the ancient, solitary sameness of the desert. The realms of the sun, sand, sage and solitude were to be subdued.

Tents dotted the scene, for an ever-increasing distance, while shacks of boards and barrel staves, and dry goods boxes, and tin cans and even liquor bottles, were being built. The newcomers and prospective millionaires—women and children and men of all ages dwelt at random and almost in the open, for all were ambitious of success in the new fields of gold. Children were turned loose to play with the burros and wild creatures of the desert, and both sexes of all ages and conditions, camped or mingled about as necessity dictated. Many were the romances and experiences of those days, that will never be fully written, for in the constructive period facilities were being employed as fast as available to build the desert metropolis. More and more people came all the time and many went, and many died from dissipation and exposure and are filling desert graves.

GLITTERING GLEAM OF TREASURE.

But the mines developed and golden, high-grade ores began to be mined in great quantities, and the leasing system had come into vogue, whereby parties owning grounds would contract with other parties that in consideration for certain development of the properties, or a percentage of the ore, they would grant for a specified time to the parties of the second part, the privilege of mining the ore.

It was under this system of mining and development that the "highgrading," or "appropriating," of ores by people employed in the mines, came into practice, and reached its zenith. Everybody who worked in the mines, whether they were in any wise a part of the management, were in line with an opportunity to get more or less profit for themselves by appropriating the rich ores that were encountered. It is an admitted fact that sums ranging from a few ready dollars up to tens and scores and possibly even hundreds of thousands, were taken away from the intended claimants of the treasure, by those engaged in high-grading.

In a very short time the constantly augmenting multitude of miners were tumbling over each other in their eagerness to get employed in the Goldfield mines. A job in any capacity around these properties was so much desired and sought after that men speculated and trafficked with each other for the privilege of such employment. Of course a good wage was paid by the operators, but, where it could be consummated it was often profitable for the men to actually buy the privilege of these positions.

THE LEASER'S DILEMMA.

Through necessity in the great rush to get out the rich ores in any manner, before the expiration of their leases, the operators were compelled to hasten. They crowded men into the excavations "as thick as bees." Their attitude was: "Boys, get it out as quick as you can. Dig it, pile it, shovel it, hoist it, haul it; we must succeed to the best possible extent before the time expires. On with the work and get us all you can, for we have no time to question."

And so it was that the leasers worked night and day with all the men that they could crowd into the holes. The profits of the leases were anything from fairly good up to the fabulous, while men came faster and faster and literally fought for room.

In addition to the profits from actual mining of ores, the leases were mostly incorporated and stocked for varying sums, usually not less than $1,000,000, and this stock the investors purchased with eagerness and varying results. But the "profits" in stock came mostly to those wise or fortunate enough to master the game.

The inevitable result could only be that when the lease expired, the leasing stock would have no further profitable basis, and the grounds would pass back to other parties.

THE INVESTOR "GETS HIS."

The unwise investor whose name was legion, did not understand but what stock in a lease was as good as any other, or perhaps better, for did he not hear of the rich ores secured, and were they not an evidence that he would get his? He did "get his," but not as he had fondly hoped. His fate was only a natural consequence of the lack of knowledge on his own part, and the desire and necessity for personal gain that prevails everywhere with "advanced civilization."

More fortunate than the ultimate buyer of these stocks, was the man who got a job during the operations of a lease, for often by slightly smothering his conscience or keeping it soaked in powerful stimulants, he filled his pockets and all the apertures and lining of his clothes, and the crown of his hat and the soles of his shoes, and his dinner-pail, or anything he could get, with the proceeds of his cunning—the rich golden highgrade, dust and ores—which he sold or traded or trafficked in for profit, and to get all that he possibly could, while the opportunity lasted.

There had naturally opened many assay offices as Goldfield progressed, but now there was a new scope and meaning to many of these assay propositions. A new and unscrupulous class of "assayers," or perhaps, many having no knowledge of chemical analyses, set themselves up in the desert metropolis to engage to some extent or another in this high-grade proposition. They purchased or secured clandestinely, and in varying quantities these ores that were being "spirited" from the operations in the rich deposits. Tons upon tons of the precious ores and golden dust passed through the hands of these alleged assayers, whose offices became more numerous than any other kind of establishments in Goldfield.

The procurers of high-grade from the properties at Goldfield did a veritable pawnshop business in their pilfering, with the many bogus assayers acting as "fences," and marketing the proceeds after paying a varying percentage to the "miners." Some special caches of the golden material even reached towards the one hundred thousand mark, and were got out of the country and marketed through varying means. A large book of such ventures and reminiscences might be written could all the facts be gleaned. Some clever rogues even played a sharp trick on their equally crooked neighbors of the bogus assayer type, by inaugurating a make-believe arrest in the guise of officers of the law. They carried away all the

rich stores of high-grade that had been accumulated by the "office."

But this condition of affairs could not long abide, for mining at Goldfield was soon to be reduced to a different method, within the full confines of the law. The high-graders had become emboldened, and were drunk with their success, a success which lavishly afforded them means for the more common forms of intoxication. Many boasted and gloated over the measure of their prowess and spent their questionably acquired wealth on games of cards and in the giddy dances and dissipations of the halls and places of indulgence.

A HIGH-GRADE HERO.

One night a bold, burly and begrimed miner stepped up to a crowded bar in a saloon that covered half a block in Goldfield and which was crowded to every wall with a conglomeration of men. There, amidst the clouds of tobacco smoke and maudlin merriment, and clink of coin and glasses, and glare of lights, he thundered:

"Come on, COME ON, you high-graders and promoters and sons of guns—come all of you and have a drink on me. I am a high-grader out at the Mohawk mine and I've got the money, you bet!'

He clapped his handfuls of gold upon the bar, until all were at attention and drank of the firey beverages.

"Drink her down, boys; drink her down," he said. "There's plenty more where this comes from—plenty more—yes, damn it, there's plenty more. Have another drink, everybody! It's free. If you won't drink on me, then drink on this money, and we'll call it on Wingfield, the owner of the mine. But I'm a high-grader and I don't care who knows it; and, damn it, more than half of you are high-graders, you sons of guns. Come on now and have ANOTHER drink, and I'll say its on the whole darned camp."

ZENITH OF THE BOOM.

And so they drunk and drank. If there were some that might not have money of their own, it was certain that most had, and the man who had not could live on whiskey. They were soaked with it—sodden with it—drinking and friendly or fighting and scheming, speculating and selling. The stock exchange was in a frenzied boom. The town was building with solid structures, and some establishments costing as high as a quarter of a million were being rushed to completion. Women and men lavished in luxury and finery, for money was flowing in through stock investments from all parts of the world, and the mines, worked by leasers and otherwise were actually producing millions. Just how much Goldfield did produce at this period will never be known, for the legitimate mint records of millions must be admitted to be meagre, because of all the stolen high-grade that went out by devious ways. Automobiles were thicker than farm wagons at a country celebration on the Fourth of July. The days of "plush and velvet," and of champagne and stock certificates and fat incomes on sales of shares, and of typewriters and boosting methods, were at their zenith. The hills and desert valleys resounded to blasts constantly tearing up the earth in and around the desert city.

HALT IS CALLED.

Money was changing hands almost by tons in games of chance; fortunes were changing hands in investments, and a giddy, lurid glare of dissipation and dance hall mirth made the days and nights pass like a drifting haze of dreams.

But the scene was destined to change. Myriads of investors who had lavished their money, often alike on good and bad securities had now begun calling for dividends or rather, more dividends. "What is the matter with the mines?" said the awakening investor. "What is becoming of our legitimate portion of the ores?" said the owners of the claims. "We will curtail the leases," said they. "We will develop and mine our own property under a more direct management. The leasing system as it has existed, is inadequate. Let us call a halt and have a clear and legal adjustment of our rights. We must and will be protected by law in the handling of our property as we choose. Organization is rampant among the workers. No longer limited to legitimate purposes, unionism is becoming a hold-up system, in which the desires and demands of an unlawful element is uppermost. They would secure to themselves, not only high wages, but also a privilege to help themselves constantly to the property of others. Let us, the property owners, demand and enforce our rights under the laws of the United States."

Then, indeed, there were rumblings and sounds other than those of merriment and industry in the mines. A considerable portion of the population was obstinate and loth to part with its illegal privileges, and profitable pilfering of the golden high-grade ores. While the inevitable change was slowly being wrought, came the nation-wide financial crash of 1907. Capitalists were planning, the populace was complaining, labor was combining and the more radical element was in control. Whatever the differing interests and demands, it was realized that established order and recognized laws must prevail. United States troops were sent to the scene, and though but few fatalities resulted at any time, it was apparent that the materials were there for combustion. The self interests of men on opposite sides had been aroused by the presence of gold—gold which most would get in any manner possible, if they could not get it by law or sufferance.

But the claim-owners, of course, were acting under established law and custom. No one could expect them to do other than act in accordance with their property rights. The Nevada State police provision, for some hundreds of armed men, came into existence and the U. S. troops, being withdrawn, the famous Goldfield properties were now to appear upon a new basis, in which capital would be protected in mining its properties in systematic, business-like and substantial way in which the profits above costs, under a free choice of labor would go only into the pockets of those having legal and rightful control.

UNDER THE NEW ORDER OF THINGS.

After some variations and smouldering revivals of the speculative spirit, we find Goldfield today progressing steadily and destined to progress as a great mining camp whose proven ores are largely owned by gigantic companies considerate of the normal needs and requirements of their employes—more generous, no doubt, than would be the "poor and honest high-graders," if they owned the same properties—for we are still at a hazy distance from that point in human progress that has been fancied by some when anything like a fabulously rich gold mine will be free to everybody.

It is a fact that the "poor and honest man" can no longer help himself to high-grade in the desert bonanzas; neither does stock in a thousand-and-one different properties from "Dan to Bersheba," sell as readily as it did in the good old days of the speculative period, when any prospect upon the deserts had more or less of a financial standing.

However, it has been demonstrated of Tonopah and Goldfield and several other of the new camps of the desert, that they are well up with the world's best mining propositions. Nevada, as a matter of fact, is one of the best mining regions in the entire world, and it is also evident that with all the scores of thousands who whirled through the lurid drama of the boom, its soil and treasure resources are practically unscratched and intact.

BUSINESS METHODS APPLIED TO MINING

By GEORGE W. SCHNEIDER.*

When one considers that the scope of the real mining business of the world at large, or even of the United States, is too vast to be readily comprehended by any single person, some idea may be had of the reluctance in attempting a discussion of such a subject as the application of business principles to mining.

The technical part of iron mining, or oil refining is, in itself, a sufficient study for any man who wishes to give a lifetime to it. When one looks at the statistics and finds that the annual mineral production of the United States alone is over two billions of dollars, and the total number of men employed in the business approximately two and one-half million, and of this total output the value of silver is less than 2 per cent; gold less than 4½ per cent; clays, lime, cement and stone, 15 per cent; pig iron, 25 per cent; coal, 30 per cent; an idea may be had of the immensity of the mineral business.

Every man, whether mine manager or not, must have five senses, but the successful mine manager must have five more, which are as follows:

1st. Technical sense.
2nd. Efficiency sense.
3rd. Square deal sense.
4th. Money sense.
5th. Common sense.

The practical mine manager; that is, the man with sufficient sense to make the most practical use of all information available, is bound to be the most successful one. The man who despises education and knowledge may have a reputation as a mine manager, but that is because he is fortunate enough to be on a good mine, which even his bad management can not ruin, or on a mine where the problems are simple, and can be solved fairly well by following the precedent established in his district. On the other hand, the best mine manager is not necessarily the man with the best education. There are men who have achieved distinction, been first-class honormen in each year of their course, have contributed able papers to the proceedings of scientific societies, who are not fit to be put in charge of a one-man show. They have not enough sense to apply properly the information they have acquired, and perhaps they have not the gift that enables men to direct and control others. At the same time, there can be no question but that in addition to the ability to organize and to make use of available information, the more thorough the education the better. No one will contradict this; even the most ardent advocate for the practical man will admit that knowledge of the subjects bearing on mining does not necessarily incapacitate a man for practical work, though he will hold that perhaps a University education does. The difference of opinion is not as to the value of knowledge, but as to the kind of knowledge necessary, and the method of acquiring it.

The gradual exhaustion of the known supplies of the richer free milling, oxidized surface ores, bonanzas and placer deposits has brought us face to face with a condition whereby what was formerly a waste has now to be considered from an economic standpoint.

Necessity is the mother of invention, and consequently ways and means are being devised whereby the different problems confronted may be solved in a manner satisfactory to the end sought. The above involves the development and application of technology, that full advantage may be taken of all the natural conditions.

The first step along this road is a sound foundation of technical training, carried on in after life, assisted by private and public-aided investigation of the natural resources and research work in different departments of science bearing upon the development of the arts of mining and metallurgy.

In former days our miners were schooled in such noted mines as the Comstock and the old districts, such as Cornwall, Georgia, California, Colorado and others, and were much sought after by the newer mining districts.

We now have the mining school which affords a sound technical training supplemented by a certain amount of practical work. The school is ably assisted by our highly efficient technical press, scientific societies, mine operators' association, and national and state research work, such as the U. S. Geological Surveys and Bureaus, which do much towards disseminating technical information.

There is another department of education bearing upon this question which may be determined secondary education. Secondary education as here used means the technical training of the working man by means of private and public schools, Bureau of Mines Rescue Cars—a new and important step adopted by the government for the prevention of mine accidents—correspondence schools, technical press, etc., all of which tends to make a more efficient operator.

The efficient manager is he who obtains the most from his labor and equipment. No matter how practical or technical he may be, a policy must be adopted involving a definite ideal, a working organization, and a distinct end in view.

The definite ideal comprises the method of developing and mining the ore deposits and winning of the metal sought, together with a selection of the equipment necessary.

Here is where volumes may be written on the mistakes from a business point of view in the employment of the wrong mining methods, building of mills before necessary, and where ill adapted, and the selection of wrong equipment. How many mines do we find over-equipped in a fashion after one's neighbor when the economic factors entering into the proposition are entirely different. Most plants are over-equipped, as evidenced by those of the U. S. Steel Corporation, which, after inspection, proved to be 60 per cent efficient. There are many cases where, after the property investigation, an old machine may be found to do the work in question much better than a new one.

To be economically successful in mine operation the proper organization, placing and discipline of the different divisions of the working force, requires careful thought and care.

No matter how perfect the mining or producing, or the organization of any of the divisions, nothing good in the way of successful operation can be accomplished unless each of the other divisions is equally well organized and works in harmony with the rest. A chain is no stronger than its weakest link.

Cost keeping in industrial establishments, as well as in mining work, has of late years been given considerably more attention than it had received formerly, and by detailed investigation the share of the various operations in the general cost of operation has been carefully ascertained. It is a very difficult matter to compare costs of different mines with each other because the conditions may vary considerably in each case. There are, however, some operations which are common to all mine work, as the ore has to be broken from the ground, and has to be transported and the metal has to be extracted. Accessory costs, such as supervision, sampling and surveying should be apportioned among those headings.

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The extent to which it is carried, however, depends largely upon the personal equation of the mine manager. There are some managers who positively revel in the multiplication of reports. Their mines are fitted up with speed counters, automatic recording pressure gauges, and elaborate systems for counting every candle, stick of powder, and piece of lagging that goes into the mine, and recording where they go. Such men must sigh for a machine that can be attached in some way to the hammer-men to record the number of blows made by each during the shift. At the end of the year's operations these managers delight in issuing elaborate reports, giving the precise cost of greasing the ropes, figured in tons of ore and waste raised, how many brooms were used in the mill, and so forth.

There are other managers who worry along with the ordinary cash book, journal, ledger, pay-roll, and bank books, and who do not pretend to understand any but the pay-roll and pass-book. Yet often, possessing the managerial faculty and having a sound knowledge of the mining business, they accomplish very fine results. When the manager is also the owner, this system (or lack of it) is readily condoned, but in the case of a salaried officer it usually means a slovenly administration.

Between the fussy manager who goes into absurd details, and the slovenly manager who pays no attention to clerical work, there is a happy mean. In cases the problem is happily solved by broadly sketching the system and placing it in the hands of a conscientious accountant who relieves the mind of the manager of the petty details. The responsible head is thus left free to attend to the broader problems that are constantly arising for solution.

The cost sheet is theoretically an infallible index to the efficiency or inefficiency of the operations of a mine. In practice, it is far otherwise. We have no doubt that many of our readers will agree with the statement that methods are unknown for doctoring cost accounts. For example, it is astonishing to see the effect on mining costs of a comparatively small tonnage of easily mined, unpayable ore. Then, too, a few simple changes of method may cut down the cost per ton, but without leading up to the all-in-all of mining—dividends.

There can be no doubt in an experienced engineer's mind that the cost sheets are excellent things, yet they can never take the place of personal supervision or mental effort. Granting freely, as we do, that cost keeping is an essential for the first-class mining administration, it seems to us that it is of paramount importance to use a unit that is logical, which the ton of ore mined or milled is not. It is often urged that the cost sheets should be published for the guidance of stockholders. The cost, per ton, is for this purpose absolutely valueless, and some other unit must be selected. We suggest reporting the costs in terms of revenue obtained, while retaining the costs per ton as memoranda for the management only.

We may dismiss as unworthy of consideration the suggestion that the cost sheets will allow of comparisons being made with other mines. The only comparisons possible are between the accomplishments of different years and of different managers in the same mine. Yet even this must be done with judgment, for conditions may have changed.

Let us take a specific case. Here was a property where the manager, in order to make a record for himself, devoted much energy to cutting down the cost per ton. He paid small dividends, owing to the lowness of the grade of ore. The ore was concentrated and a saving was claimed of 70 per cent, although it is actually only 64 per cent. He was succeeded by a manager who thought less of the cost per ton than he did of dividends. The new manager put more miners at work, although the same tonnage was sent to the mill. The mining, however, was done more carefully, and the value of the ore sent to the mill was raised from $7 to $8.50 a ton. In the mill the new manager was not satisfied with the savings. He replaced the foreman by a much higher-priced man, put more men on the machines, all on the same tonnage. The result was that instead of saving 64 per cent, an actual recovery of 72 per cent was made. His cost sheets showed an increase per ton from $3.95 to $4.72, something that would invite criticism from ignorant stockholders. However, his net earnings went up from 63 cents a ton to $1.40, and the annual profit from about $40,000 to slightly over $100,000. This is a striking example of the fallacy of judging a management by the lowness of the working costs.

Large mining companies usually have admirable systems for transmitting information between the executive head at the mines and the company headquarters.

When, however, the far greater number of small mines are considered, situated often two or three thousand miles from headquarters, we find that in the great majority of cases absolutely no system is used, either at the mine or at the home office. Too often doubt and uncertainty exist on both sides, resulting, of course, in friction, demoralization and inefficiency. The manager is never quite certain as to whether he will receive drafts for payment of the mine accounts, and the directors can make neither head nor tail of what is being done at the mines, in spite of numerous "explanatory" letters and statements forwarded by the manager.

This state of affairs in small mines does not necessarily imply that there is not a sincere desire on both sides to furnish information. The fact is, however, that no system worthy of that name is used in such cases. Letters, while useful enough to explain properly rendered accounts and details of mining and milling operations, can never take the place of the latter. A properly devised system insures full reports each month and such reports that comparisons can be made at periodical intervals; they require care in drawing up, force the manager to work systematically and thus finally bring about efficiency in the management of the mine. It is an absolute truism that the most vigilant check on the management and the hardest taskmaster is a clear and precise report on each month's work.

We venture to assert that if the smaller mining companies would at the outset of their enterprise engage a man of broad experience in mine organization (not a doctrinaire) to devise a system adapted to the needs of the case, fewer failures would be made; the managements, especially in isolated spots, would be more efficient and the unprotfiable nature of some ventures would be sooner discovered than in the case where no proper system of monthly reports exists. Many excellent mining men do not understand how to draw up such report forms; in such cases the services of an expert may be engaged. Directors of mining companies owe it to their stockholders to have frequent, accurate, and systematic reports, as to progress of work, where and how expenditures are made by the manager, etc.

As a general rule, mines are made. By this I mean that from its discovery it is not always self-sustaining, but requires the assistance of capital for the necessary development and equipment to put it on a paying basis.

In the securing of such capital, pools, companies, or corporations are organized and here is where the application of a square deal is very necessary, for what do we find:

In some cases companies are organized having no equity in anything whatever for the protection of the investment, holding, perhaps, only an option or a lease on a number of undeveloped locations situated twenty-five or thirty miles from some noted mine. All the stockholder receives is a gilt letter stock certificate showing how much he has paid, and a highly illustrated prospectus; in other

cases, the value of the property and its possibilities are greatly exaggerated by false reports; in others, the organization of the promotion scheme, which involves a large capitalization, is such that possibly not more than 15 per cent of the capital raised ever reaches the mine or prospect for development, but finds lodgment in the pockets of some promoter who maintains a healthy press bureau, a handsome suite of offices, and other luxuries. In other words, we have frenzied finance in all its phases.

When, however, the necessary capital does reach the mine, the interest of the stockholders who furnish the capital should be kept plainly in view, for how many instances do we find where everybody concerned with the proposition has received a square deal, except the stockholder who holds the bag?

Again, the manager owes it to his stockholders to be honest in all his transactions, free from the taking of all bonuses on all contracts or commissions on equipments or supplies bought, for he sells his services to them and if underpaid should not serve.

The manager not only owes it to his stockholders, but to the mine and community to maintain his ore reserves, which means putting another ton of ore in sight for the one mined. How many mines can we find idle today because the management did not get far enough ahead to see the importance of keeping his development in advance for the purpose of maintaining his ore reserve.

The manager in maintaining his ore reserves is called upon to do much work of a prospective nature, and in doing so, benefits the whole community for what he discovers is apt to be common to others, as is strongly evidenced by the recent zinc strikes and discovery of values in the granite in this very district.

And that leads to another point—while new camps are much to be desired, there is nothing to my mind which offers inducements like the thorough prospecting and developing of the mineral zones existing in the old camps, as modern mining and metallurgy have found ways and means of treating ores which were out of the question only a few years back.

When we consider what Mexico is doing in a mining way, and that practically no new camp has been found during the past century, with the possible exception of Cananea, it certainly presents us food for thought.

The owner of the prospect or mine requiring capital for development owes to the one ready to furnish the necessary capital a disposition to meet him on equal terms by allowing the privileges of performing such development work under the terms of a bond and lease, with restrictions as to the removal of ore, etc., and not demand exorbitant cash payments or unreasonable requirements.

The nation, state, and community owe to the prospector and miner such equitable laws and regulations as will encourage the prospecting for and seeking out of new mineral localities. Our business and mining men are clamoring for a new district, so much so that one civic body is furnishing funds to that end, and not without cause, for it is necessary to maintain future ore reserves and nothing acts as a greater stimulant to all business in general than the discovery of a new camp with merit.

The community owes a square deal to the stockholder in so far as it is compatible with the existing conditions, for a failure of any mining venture has a reactionary effect. How many instances have we of failures hurting a camp which could have been prevented if taken in time!

Again the mine management owes it to the community to refrain from contracting debts without knowing how they can be met or the creditors protected.

A square deal to the working man is imperative, be he an American miner, Mexican peon, or South African negro, for no efficiency may be expected from one who is underpaid, underfed, and badly housed. It will be made up in some way, and generally at a disadvantage to the employer.

An American miner receiving $3.50 per day is more efficient and produces more metal at less cost than the East Indian miner who receives 19 cents per day.

Whether the work be performed by task, days' pay, or contract, or a leasing system is in vogue, a just and equitable agreement should be made, entered into, and lived up to by all parties concerned.

Let the Golden Rule be, "Do unto others as they would do unto you," and not, "Do unto others as they would do you, but do it first."

Money sense in mining is the supreme faculty, and a man who possesses this faculty will bring it to bear on every problem he has to face.

The aim of mining is to make money, and one would expect its economic aspect to be understood by those who enagege therein.

The principal phase of the money sense comprises two important factors; first, the ore "in sight" which can be turned into dividends, and second, the prospects for the future beyond what can be considered "in sight." In other words, mine valuation.

Hoover states in his "Principles of Mining:" "It should be stated at the outset that it is utterly impossible to accurately value any mine, owing to the many speculative factors involved. The best that can be done is to state that the value lies between certain limits, and that various stages above the minimum given represent various degrees of risk. Further, it would be but stating truisms to those engaged in valuing mines to repeat that, because of the limited life of every mine, valuation, of such investments cannot be based upon the principle of simple interest; nor that any investment is justified without a consideration of the management to ensue. Yet the ignorance of these essentials is so prevalent among the public that they warrant repetition on every available occasion."

Another phase of the money sense is the economic factor, which embraces such uqestions as—

Government,
Climate,
Transportation,
Water,
Fuel,
Labor,
Metallurgy,
Management.

Each of us is quite sure he possesses all the common sense needed, and this is also an important instinct, since without it we would lack self-confidence, initiative; we would be deficient in the ability to do, to accomplish.

Another term for common sense is "personal factor," which, in some, means much; in others, little. To some it means years of experience, to others, especial adaptation or genius.

Common sense means construction, conservation, or, in other words, making two blades of grass grow where one grew before.

The application of the conservation of natural resources by reclamation, as applied to mining, finds its highest type in this camp, which is known as the camp of many metals. And why? Because you in your evolution have mined that which is required without unnecessary sacrifice. Gold, as is natural, was the pioneer on account of its occurrence and value. Then came silver and lead, followed by manganese. Now the zinc era is at hand. Others will follow, showing that no metal or mineral of economic importance will be allowed to go to waste, but must add its share to the permanent mineral wealth of the world.

Another illustration of the application of common sense. Our waterways are harnessed and converted into electric power, which is transferred over small copper wires to the individual mines and mills, there to pump water, compress air, hoist and transport ore and waste, which has been mined by modern pneumatic and electric machinery, and finally reduce the ores to the metals sought.

When we consider that these same waters are allowed to go on unsullied to

the farmer to be used to irrigate his property, which in its turn, adds to the world's wealth, an illustration of the constructive policy, as applied by common sense to mining, is presented, which shows that we are moving onward and upward.

And the end is not yet, for we are on the threshold of electrometallurgy, which will find its highest development in our midst.

To select an upbuilding constructive organization, carefully to determine and adhere to ideals, constantly to survey every problem from a lofty instead of from a near point of view, to seek special knowledge and advice where they can be found, to maintain from top to bottom a noble discipline, to build on the rock of the Golden Rule, of the square deal—these are the problems which common sense must solve.

After all is said and done, we must conclude that the last sense (common sense) is paramount and implies a familiarity and knowledge of the other senses.

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SOME LOCAL SIDELIGHTS

The City Commission a few days ago promulgated a new ordinance requiring storekeepers to have their sidewalks swept clean by 8 o'clock every morning. At the same time the Commission permits the street cleaning department to operate its flushing wagon in the business district during the most active hours of the business day. Intersections of the principal streets are flooded and pedestrians are compelled to either wade through rivers of water and filth or else seek safety indoors till the scavenger crews get through. Great system.

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Judge Charles S. Varian, recognized as one of the foremost lawyers in this city and a sterling, progressive citizen, resigned as corporation counsel for Salt Lake about the middle of the month. Judge Varian is the second individual to resign the same position since the first of the year. He simply declined to impair his self-respect by serving longer.

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Those asserting a familiarity with the affairs of the Utah Copper company believe that one of the next most interesting announcements to be made will be that the officials have decided upon additional mill capacity. How long this will be delayed depends upon two principal factors, first, the ability of the mine to supply the ore, and second, the stability of the copper metal market.—Salt Lake Tribune, April 18.

BROWN AND BLUEPRINTS

Brown-prints are prints similar to blue-prints, except that they are made on brown-print paper instead of blue-print paper. If a print be made on brown-print paper from a tracing as a negative, the print will show white lines on a dark brown background. This paper requires a little longer exposure than rapid blue-print paper, and must be washed three times, first in clear water from three to five minutes, then in a solution of fixing salt and water for about the same time, and finally are rinsed thoroughly in clear running water. The fixing salt is hypo-sulphite of soda, and a can comes with every roll of paper. Use in the proportion of half an ounce to a quart of water.

From the brown prints made as above, showing white lines on a brown ground, other prints can be made by using the brown print instead of a tracing. If these other prints be made on the same kind of paper—brown-print paper—they will show brown lines on a white ground. If ordinary blue-print paper be used, there will be blue lines on a white ground. These secondary prints require a longer exposure and must be carefully made in insure clearness. The white ground is convenient, because additions can be made on the print in pencil or ink. Brown-prints are much used because of the fact that tracing can be made and kept at a central office and brown prints from them distributed to the various agencies or branch houses which are then enabled to make for themselves as many duplicates as are required.—Mining and Scientific Press.

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Mr. Frank H. Probert announces that the firm of Weed and Probert has been dissolved by mutual consent and that hereafter he will practice as consulting engineer and mining geologist, with headquarters in the Central building, Los Angeles.

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The College of Mines of the University of Washington made its spring excursion for the mine inspection to Texada Island, British Columbia, from March 28th to April 6th. The party consisted of twenty senior and junior students accompanied by Dean Milnor Roberts and Prof. Joseph Daniels. The objects of the trip were to study the deposits of iron, copper, gold and limestone, and to inspect the lime kilns, oil-burning smelter and mining equipment of the region. Headquarters camp was established at Van Anda, near the north end of the island.

The difference in temperature of the outside air during the changes in seasons often exercises an important influence upon the ventilation of mines, this being due to the fact that in winter the outside air is cooler than that within the mine and in the summer warmer. This change will often effect a change in the air currents and as the outside temperature approaches that of the mine, there will be no natural ventilation except as this may be caused by wind pressure.

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An ordinary drill may be hardened in sulphuric acid, making an edge that will cut tempered steel and facilitate in cutting hard rock. The acid should be poured into a flat bottomed vessel to a depth of about one-eighth of an inch. The point of the drill is heated to a dull cherry red and dipped in the acid to that depth. This makes the point extremely hard, while the rest remains soft. If the point breaks, reharden but with a little less acid in the vessel. After hardening a drill in this manner, wipe off the acid, if any remains on the point of the drill, before it attacks the metal and destroys the cutting edge.

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Gold may be freed from lead in smelting zinc-box precipitate by the use of a flux containing 60 percent borax, 19 percent niter, 11½ percent sand and 7 percent soda. Manganese dioxide is said to be more efficient than nitre in oxidizing the lead, and for fusing 100 parts of the slime as a flux composed of 20 to 35 parts of borax, 20 to 40 parts of manganese dioxide and 15 to 40 parts of sand, is highly recommended. Gold recovered from alluvial work is usually nearly free from base impurities and can be melted down with a little borax glass and nitre. Flourspar, when available, is a good flux as it is very liquid when molten.

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The International Society of Mining Accountants was organized in March. The objects of this new society are to promote the science of accounting and allied subjects connected with the production of the useful minerals and metals on the American continents, by means of an annual meeting for social intercourse and the reading of practical papers on accounting, etc., and the publication of the proceedings in an annual volume. There are two classes of members, active and honorary. Membership is open to any person interested in the subjects of the society, provided they are actively engaged in mining or allied industries. The Secretary is W. H. Charlton, 46 Hooker Ave., Detroit, Mich.

LEACHING APPLIED TO COPPER ORE* (XVII)

ELECTROLYTIC DEPOSITION OF COPPER FROM SOLUTIONS

By W. L. AUSTIN.†

That branch of hydrometallurgy which has for its objective the extraction of copper from its ore, must necessarily be affected by the cost of the lixiviants employed. Therefore, modern methods of preparing chemical reagents through electrolytic treatment of solutions containing common substances, (such as chloride of sodium), have become of great importance in this connection. This industry has made notable advances in recent years and it is now profitable to manufacture chemical compounds in large quantities in comparatively remote localities, for instance in the mountains of the Scandinavian peninsula where water-power is abundant. Furthermore, waste products, such as the obnoxious sulphur-dioxide present in gases emanating from smelting-works, can now be turned to useful purpose by aiding in the production of acid lixiviants suitable for application in leaching ore. By combining the products of electrolysis with sulphur-dioxide, strong lixiviants may be obtained from substances available almost anywhere, the necessary factors being cheap power, sulphide ore, and common salt—the latter in small quantity.

As an elementary knowledge of the basic principles of electrolysis is essential to intelligent application of this powerful auxiliary for modern hydrometallurgy, it is proposed to briefly treat of this matter. In the following an effort will be made to place before those interested in the subject some succinct facts regarding electrolysis, which it is hoped will be useful in advancing the art as applied to extraction of metals from ore. This is not written for those proficient in electrolytical matters, but for the many who from one cause or another have been prevented from keeping up with progress in this branch of science, and who are attempting to get results without adequate knowledge of the subject. The very technical terms employed by writers on electrolytical matters are often confusing to the practical man, and much of the information given in text-books is far from being clearly stated. Whereas the "cut and try" method of advancement may sometimes lead to satisfactory results, it is usually more economical both as to time and cash expenditure, to first obtain information with regard to what has already been accomplished in any line of industry, and as to the scientific facts upon which it rests, before embarking upon a campaign of what may in the end prove to be merely re-discovery of well-known facts. Lack of information is the cause of much useless experimentation, and the various branches of technology are so highly specialized that it has become very difficult for one unfamiliar with any particular industry to acquire a working knowledge of it in a short space of time.

When a direct electric current is made to pass through a solution containing copper-sulphate, the points of ingress and egress of the current being two separate sheets of copper (electrodes), metal is dissolved at the anode (electrode at which the current is said to enter the solution), and is redeposited on the cathode (electrode at which the current leaves). The quantity of metal going into solution at the anode, and which is redeposited on the cathode, is in direct proportion to the strength of the current employed. A measuring instrument called a voltameter has been devised, one type of which is based upon the deposition of copper from a copper-sulphate solution (using copper electrodes) during the passage of an electric current. It is used for determining the quantity of current flowing through a circuit in a given time—the weight of the copper deposited indicating the quantity of current transmitted. In experimental work where changes in the strength of current supplied are apt to occur, due to reactions taking place in the electrolyte (liquor containing the metal to be deposited), it is always well to have a voltameter in the circuit to serve as a check on the readings of the voltmeter and ammeter.

ELECTROLYZING WITH INSOLUBLE ANODES.

In electrolyzing a cupriferous liquor, if instead of a copper anode one is employed which is composed of some material not acted upon by the liquor, or by the products generated, and which therefore does not go into solution (insoluble anode), then copper is still deposited on the cathode, but it is taken out of the liquor, without an equivalent amount of metal being dissolved at the anode, as in the instance just cited. It is evident, therefore, that in the latter case the electrolyte is undergoing constant alteration as to its chemical composition and other properties, and hence as to its function as an electrolyte—an element of considerable importance when making theoretical estimates with regard to the amount of current required to deposit a specific quantity of copper from a cupriferous bath, using insoluble anodes.

When an ore has been roasted with a view to the production of copper sulphate, the roasted material may be leached with water, and the lixivium thus obtained may be used as an electrolyte. In the electrolysis of such a lixivium, if an insoluble anode is employed (carbon for instance), copper may be removed from the electrolyte and be deposited upon a copper cathode. The operation which consists in passing an electric current through a cupriferous liquor with the object of depositing the contained copper, is termed electrolysis. In refining copper electrolytically, which is now done upon a very large scale, plates cast from crude-copper at the smelting-works are employed as anodes, and metal is dissolved from them and deposited upon sheets of pure copper used as cathodes. However, refining crude-copper plates differs materially from depositing copper out of cupriferous solutions derived from ore-leaching operations. For such work insoluble anodes must necessarily be employed, and the amount of current consumed per pound of metal deposited is much greater in treating liquors obtained in leaching ore than in refining operations.

As a preliminary to considering the practical bearing of electrolysis upon the hydrometallurgy of copper, it is necessary to understand the nature of an electrolyte, and an explanation should be offered why some liquors afford a passage for the electric current while others do not. Liquid conductors of electricity are termed conductors of the second class, thereby distinguishing them from metallic conductors, or conductors of the first class. An electric current will flow through a metallic conductor without producing an appreciable alteration in the conductor—

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it flows without transportation of matter: when an electric current passes through a conductor of the second class there is always a transportation of matter, and usually chemical transformations are brought about.

Formerly it was thought that the electric current in passing through a copper sulphate electrolyte broke up the copper salt into two parts—(1) copper, and (2) a combination of sulphur and oxygen (SO_4). Such an hypothesis was quite natural, because metallic copper made its appearance on the cathode, and sulphuric acid accumulated in the liquor. Still several phenomena were observed which this theory could not satisfactorily explain. A closer study of the subject resulted in the development of the modern theory of ionization, a knowledge of which is essential in trying to explain reactions taking place when cupriferous liquors are subjected to electrolysis.

IONIZATION THEORY.

In refining crude-copper, inasmuch as copper is deposited at the cathode in the metallic state, and the metal composing the anode gradually goes into solution as sulphate, thereby maintaining the copper-sulphate strength of the liquor, the observed facts appear to explain the phenomena in the manner stated above; but at the same time it would seem reasonable to suppose that in the beginning of the operation a considerable force would be required to separate the metal from its associated acid-radical. Such, however, was found not to be the case—at least as far as concerned the work done by the current. Experimentation disclosed the fact that the smallest observable difference of potential between the electrodes of a copper voltmeter sufficed for transmission of current with the accompanying phenomena. In other words, it was found that an electrolyte would transmit a current without the latter exerting an appropriate force, such as would be necessary to tear apart a strong chemical combination. This interesting fact introduces the question as to the manner in which an electrolyte transmits the electric current.

When sugar, salt, and many other substances are thrown into water, they disappear as such, and it is said they are dissolved. They can be readily recovered by evaporating the water, but it is evident that when in the dissolved state their prior conditon must have been temporarily altered. If it were known, therefore, what happens to salt (NaCl) when it dissolves, then an explanation might be forthcoming as to why pure water is an extremely bad electrolyte, yet water with salt in it is a fairly good conductor.

The above mentioned, and other observed facts, led Arrhenius to formulate the hypothesis that all solutions of salts which are conductors of the electric current no longer contain the said salts in their original status, but that these salts are broken up to a greater or lesser extent (electrically dissociated) by the act of solution. The extremely small particles into which such salts are resolved in an electrolyte are termed ions. They are considered to be smaller than the old chemical molecules and atoms which before their advent did service in explaining chemical and physical phenomena. In addition to being a separate entity, each ion is thought to be combined with a definite quantity of electricity. It is not proposed here to enter into a discussion of the modern theory of solvation; nor to consider the ultimate composition of matter: attention will be directed only to such observed facts, and theories, as have a direct bearing upon practical electrolysis.

It is, at first thought, a severe tax upon the imagination to accept the idea that in dissolving common table-salt in water the liquid no longer contains the said salt in the form in which it was known to exist the moment before solution: that the salt in dissolving splits up for the greater part into sodium ions and chlorine ions, two of the most energetic chemical elements known to exist. A further difficulty presents itself in trying to imagine these substances as existing side by side in solution without their entering into combination with the elements of the water or with each other, and it becomes necessary in explaining the phenomenon, to advance the additional hypothesis that each elementary ion is itself combined with something which temporarily neutralizes its affinity for other chemical bodies. It is therefore assumed in the case at point that each sodium ion is combined with a charge of positive electricity, and that each chlorine ion is similarly combined with a charge of negative electricity. The electric charge combined with any ion, of whatever element, is assumed to be equal to that combined with each of the other separate ions, and as the sum of the positive electric charges must be equal to that of the negative, this is offered as an explanation of the fact that the solution remains electrically neutral. In the case of copper sulphate, the copper ions (cathions) are combined with charges of positive electricity; the SO_4-ions (anions) with charges of negative electricity.

WHY AN ELECTROLYTE CONDUCTS CURRENT.

With the help of the above mentioned hypothesis, it is possible to suggest a tentative explanation of the manner in which an electric current obtains passage through an electrolyte. Granting the presence of small particles of elementary, or combined substances, in a solution, which particles are associated with charges of electricity of opposite sign and are free to move in any direction, it is easy to understand that if two electrodes are introduced into such a solution—the one connected with a source of positive electricity, and the other with negative—that then the negative ions will be attracted to the positive electrode, and the ions combined with positive charges will move towards the negative electrode. Naturally also all the ions present in the solution will be set in motion as soon as there is the least electrostatic attraction offered by the two electrodes, and this explains why a current can pass through an electrolyte even when the electromotive force would have been insufficient to disrupt the combination of elements present in the salt before solution—the current simply attracts or repels the particles already dissociated by the act of solution.

Upon the arrival of the ions at the electrodes to which they are attracted, their charges are neutralized, and the ions themselves, deprived of their associated electricity, are free to unite to form molecules. Such is the hypothesis advanced by the foremost physicists of the day in accounting for the fact that when a solution of copper sulphate is introduced into a circuit through which an electric current is passing, metallic copper appears on the cathode plate and sulphuric acid collects around the anode.

However, a current passing through an electrolyte not only acts on the ions into which any particular salt—copper sulphate for instance—has been resolved, but it affects the ions produced by solution of other salts which may be present. No distinction is made by the current between the SO_4-ions originating in the solution of copper sulphate, and the SO_4-ions derived from sodium sulphate, sulphuric acid, or any other source. The same with metallic cathions—copper, sodium, etc. It follows that in electrolyzing a liquid containing substances other than those which are the object of the operation, where insoluble anodes are used, much of the current may be uselessly applied to production of hydrogen through the decomposition of water by metallic sodium deposited on the cathode when sodium sulphate happens to be present. The sodium hydrate thus formed naturally recombines with sulphuric acid produced at the anode, and the cycle recommences, unless the anode liquor (anolyte) is prevented from mixing with cathode liquor (catholyte) by introducing a screen (diaphragm).

Furthermore, chemical compounds produced in an impure electrolyte by the

passage of a current, combine among themselves, forming new bodies which sometimes vitally affect the operation. These can accumulate in a bath until present in such quantities as to reverse the predetermined course of the reactions. It is quite possible in attempting to electrolyze a cupriferous liquor containing iron salts without employing a diaphragm, that the energy of the current is wholly expended in producing a cycle of chemical reactions without deposition of copper.

Then the removal of copper from a bath, due to deposition on the cathode, is constantly altering the relative proportions of the substances in an electrolyte, which in turn affects the degree of ionization, and conductivity. The temperature of the bath also influences the operation: a certain set of chemical compounds may be produced at a given temperature, while another set forms at a different degree of heat. For instance, in the electrolysis of a chloride of sodium solution, hypochlorites are produced at one temperature of the bath, chlorates and perchlorates at another temperature. These different phenomena can best be illustrated when considering specific cases in which they occur. Beginning with some simple examples of galvanic action, others more complex will be taken up later.

ACTION OF AN IRON-COPPER COUPLE.

If a galvanic couple consisting of two metals such as iron and copper, (which are placed at some distance from each other in the electromotive series), be immersed in a dilute copper-sulphate solution, and are connected outside the solution by means of a conductor of low resistance, then a current will flow through the solution from the iron to the copper. Under electromotive series is understood such an arrangement of different metals in a series that each one becomes positively electrified when placed in contact in air with the metal next below in the series. The precipitation of copper from mine-water by means of scrap-iron, an operation which results in the formation of innumerable galvanic couples, is an illustration of this phenomenon which comes under frequent observation. If a piece of coke be attached to a tin can by an iron wire and the combination be allowed to float upon the surface of a stagnant pond containing ordinary mine-water, even though the copper content of the water may be so slight as not to affect the coloration, the quantity of the latter metal precipitated upon the couple is extraordinary. There is more copper deposited than would be expected from contact of the couple with the water in its immediate vicinity, and may be explained by electrostatic attraction of copper ions from the surrounding liquid for a considerable radius. Carbon occupies a position near the negative end of the electromotive series, but apparently changes its position considerably according to the form (coke, charcoal, and graphite) and the manner of preparation.

If an iron plate and one of copper be placed in a copper-sulphate solution, and the two be connected outside the liquor by means of a copper bar, the two metals constitute the elements of an electric battery, and the current flowing through the bar can be measured—it can also be calculated from thermochemical data. The two results may not always agree because theoretical estimates are based upon data obtained with pure solutions whereas in practice the liquors usually contain other salts than those under immediate consideration. However, an estimate of the quantity of current required to deposit a given amount of copper from cupriferous solutions, using either soluble or insoluble anodes, often yields information of value in considering the cost of different methods of precipitation in ore-leaching operations. For instance, with a given cost of current, by this means it is easy to ascertain which is the least expensive agent for precipitation—iron or electricity. The theoretical method of reaching such conclusions is less expensive than the erection of elaborate plants, which in the past have often served merely to demonstrate the limitations of electrochemical reactions. It is not uncommon to hear the statement made that the amount of current required to deposit copper from liquors derived from leaching ore is a "negligible quantity," and the promulgation of this erroneous idea may account for the fact that a number of plants built with this end in view have ceased to attract attention shortly after beginning operations.

THERMOCHEMICAL CALCULATIONS.

In thermal chemistry the quantity of heat set free by the union of two elements, (as illustrated by the combustion of charcoal in air), is considered equal to the amount of heat necessary for the separation of the same elements. By reference to thermochemical tables it will be found that when 55.9 grams metallic iron combine with oxygen and sulphuric acid to form the ferrous salt, and this salt is dissolved in an abundance of water, then there are liberated 93,200 calories: when 61.8 grams metallic copper combine with the same substances, under similar conditions, to form copper sulphate, then 55,960 calories are set free. A calorie is understood to be the quantity of heat required to raise the temperature of one gram of water one degree Celsius—that is, from 15° to 16° C. The difference, therefore, between the quantity of heat evolved by the corrosion of 55.9 grams iron in a battery such as referred to above, and the quantity of heat liberated through the deposition of an equivalent amount (61.8 grams) copper on the negative pole, is 93,200—55,960=37,240 calories. This represents an excess of anode-energy expressed in heatunits (calories) when the specified weight of iron is corroded in a battery using a solution of pure copper sulphate as electrolyte: with the deposition of 30.9 grams copper only half the amount of iron will be consumed and the excess anode-energy will be 18,620 calories.

Heat being a form of energy, it must be related to other forms—mechanical and electrical—and one form of energy must find expression in terms of either of the others. It has been determined by experiment that the energy represented by one calorie is equivalent to the force required to raise 42.6 kilograms one centimeter, and also equals 4.189 units of electrical energy (4.189 watt-seconds= 4.189 volt-coulombs). It has been further determined that one ampere of current, flowing for one second (one coulomb), will deposit 0.001118 gram silver from an argentiferous solution. As the atomic weight of silver is 107.93, to deposit 107.93 grams of this metal (one gram-equivalent) will require $\frac{107.93}{0.001118}$ =96540 coulombs of current. This fundamental electrochemical constant (96540 coulombs) is called a Faraday, and represents the quantity of electricity supposed to be associated with the ions contained in one gram-equivalent of any univalent element. To release a gram-equivalent of any such element from solution it is (theoretically) only necessary to pass 96540 coulombs of electricity through the said solution.

Silver is a univalent element: copper is both univalent and bivalent—univalent in cuprous salts; bivalent in cupric. The same amount of current which suffices to deposit one gram-equivalent of a univalent element from a solution, separates only half of a gram-equivalent from solutions of a bivalent element. As copper combined with sulphuric acid in the form of copper sulphate is bivalent, one Faraday will deposit only half a gram-equivalent ($\frac{61.8}{2}$=30.9 grams) of this metal. Now, as 4.189 amperes of current flowing for one second at one volt pressure (1 volt-ampere-second=1 volt-coulomb) is equivalent to one calorie, therefore $\frac{96540}{4.189}$ =23046 calories represent the heat energy necessary to deposit one-half gram-equivalent of bivalent copper. As it was shown above that one Faraday sufficed (theoretically) for the deposition of 30.9 grams bivalent copper, and as the corrosion of the iron in the case of the battery under consideration yielded an excess anode-energy of 18,620 calories, such a

battery should be able to produce a difference of potential equal to $\frac{18620}{23046} = 0.87$ volt.

The result indicated would be the theoretical difference of potential for an iron-copper couple immersed in a dilute copper-sulphate solution, but the available voltage would be less than the figures given because the flow of current would meet with resistance. The electrolyte would interpose resistance proportional to the distance between the electrodes; the external conductor joining the electrodes through the air would offer further resistance dependent upon its length and cross-section; and additional resistance would be encountered at each point of contact between conductors. Tables are available showing the amount of resistance offered by various metallic conductors of different cross-section: if these conductors are sufficiently large this resistance does not vary materially during an operation. With conductors of the second class (electrolytes) the case is different, because the consistency of the liquor is constantly changing.

RESISTANCE OF AN ELECTROLYTE.

The resistance offered by an electrolyte to the passage of a current is usually given in ohms per cubic centimeter. A resistivity of 50 ohms, for instance, means that a resistanee of 50 ohms is interposed between electrodes of one square centimeter section for every centimeter that they are separated. A copper sulphate solution containing five per cent of the salt offers a resistance of about 53 ohms per cubic centimeter. Solutions which are more concentrated, or more dilute, differ very much in resistivity. Tables are prepared which give the resistivity of various salt solutions at different degrees of concentration. Increasing the area of the electrodes decreases the resistance offered by an electrolyte in the case of a specified current.

Richards, in "Metallurgical Calculations," Part III, page 524, gives an estimate of the amount of copper which would be deposited per diem in a vat containing fifteen anodes of cast-iron and sixteen sheets of copper of same size, which would be simply an enlarged battery of the type above described. It is assumed that the copper-sulphate solution (about 5 per cent) has a resistivity of 50 ohms, and that the electrodes are placed 5 centimeters apart. The electrodes are short-circuited by resting on a triangular copper distributing bar of negligible resistance.

As the iron anodes are supposed to be hung between the copper cathodes, each anode operates from both sides, and as each anode is 40 by 80 centimeters in size, the total anode-surface is 40x80x15x2 =96,000 sq. cm. The loss in voltage due to contacts between electrodes and conductors is assumed to be 0.1 volt, and as it was shown above that such an arrangement of elements would yield an electromotive force of 0.87 volt, the available voltage to overcome ohmic resistance will be 0.87—0.1=0.77 volt. A resistivity of 50 ohms per cu. cm., spread over 96,000 sq. cm. surface, gives an ohmic resistance for the whole apparatus of $\frac{50}{96000} \times \frac{5}{1} = 0.0026$ ohms.

Now, as current $= \frac{\text{voltage}}{\text{resistance}}$, the quantity of current which will flow through a vat of this description will be (theoretically) $\frac{0.77}{0.0026} = 296$ amperes. The quantity of current per square centimeter of anode surface (that is, the current density) will be the stated number of amperes divided by the total number of sq. cm.: this will correspond to 30.83 amperes per square meter.

The quantity of bivalent copper deposited by one ampere of current in one hour is 1.184 grams, therefore, in one day 296 amperes will deposit 1.184x24x296 =8,411 grams. As the relative atomic weights of iron and copper are as 55.9 to 61.8 and as an atom of iron is corroded for each atom of copper deposited, there will be an expenditure of 7,608 grams of iron in depositing 8,411 grams of copper. This is assuming the iron to be chemically pure: it will, of course, require more of the scrap-iron usually employed for precipitating purposes than the above results indicate.

The calculation just given shows that under favorable conditions iron can precipitate more than its weight of copper from a moderately weak cupriferous solution. The reason that in practice more iron than the theoretical quantity necessary is consumed for this purpose, is due to two causes: (1) the iron used is dirty, or impure; (2) the access of air to the liquors causes complications. With regard to the last mentioned fact, when iron is dissolved at the anode the ferrous salt is produced, and this is very quickly oxidized by contact with air to ferric sulphate. Ferric sulphate not only re-dissolves some of the copper already deposited on the cathode, but it also attacks metallic iron. Hence, to deposit copper economically from weak cupriferous liquors it is essential to exclude the air from the vats as far as possible.

(To be Continued.)

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To conduct successful reverberatory smelting operations with gas, it is necessary that the furnaces be regenerative and so must be large and necessarily expensive in construction. Such furnaces are widely used in the manufacture of open hearth steel. Oil and coal-dust fired furnaces are at present coming into favor in copper reverberatory furnace operations.

HOW TO MAINTAIN A GR

In driving and tunnel work the
unconsciously tend to work on
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Too much grade is disadvantageo
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ally noticeable at the face; and, i
cases, the unnecessary loss of ore
backs above the drift may be unde

The grade of drifts in some
older mines of Cornwall is as g
5%, often 7%. At the present
drift is rarely driven at a greate
than 1%, which is twice the grade
mended by some authorities.

To avoid driving at too great a
a template should be provided wh
miners can use as often as they
and without losing much time.
template may be made by cutting
of convenient width and thickness
it is exactly 100 in. long. The
should be planed true and paral
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of one end to a point one inch bel
upper corner of the opposite e
the board sawed along this line
board is then turned over, and a
tube let into the edge, which is
justed that the bubble will be
center of the tube when the edge
board is in a horizontal plane.

In use, the template is laid up
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toward the face. Then if the gr
the floor is 1%, the bubble will be
center of the tube.

———o———

A rough method for determinin
flow of a stream is to select son
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This multiplied together will gi
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Put a float on the water and note
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measured, from this can be dete
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second. Multiply this by the a
cross-section in square feet and t
duct will be the cubic feet per
of flow. Reduce the result by on
to allow for the change in veloc
tween the surface velocity and a
velocity of the stream.

Mines and Methods

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CONTENTS:

For nearly one month, or since the first day of May, there has been a strike on at the Murray plant of the American Smelting & Refining Company and the difficulty has not yet been adjusted. It is claimed that the trouble arose over the men demanding a raise from $1.75 to $1.90 a day, to $2.25. The company has seen fit to ignore the demands of the men and, as a result the plant, which was only running five of its eight furnaces before the strike, is now able to keep only two or three of the furnaces in blast. While nothing of the kind, of course, is acknowledged it seems probable that the company has been reading the "hand-writing on the wall" and sees its finish, anyhow. One by one the old patrons of the concern have been transferring their business to the International Smelting Company's plant at Tooele and the prospects are that the American (Guggenheim) crowd is, with respect to its lead smelting operations in this state, beginning to realize that its "survival of the fittest" proclamation of about three years ago is not destined to work out as it expected. Maybe the company is preparing to take advantage of the demands of its employees as an excuse for closing down the works permanently. Not many of the lead-silver ore producers of Utah will shed any tears if such proves to be the case.

Sloughing Off Utah Copper

A Few Remarks Tending to Show the Great Faith (?) which Mgr. Jackling and Prest. MacNeill Have In the Value of their Reports and Share Holdings.

Those of our readers who have taken seriously the annual reports of Manager Jackling and President MacNeill of the Utah Copper Company for the years 1910 and 1911 will doubtless be surprised to learn that both of these gentlemen have been unloading Utah shares during the last twelve months at a rate which, if continued will, before the close of the present year, find them with an insufficient number of these gilded evidences of wealth to qualify them as members of the Steam Shovelers' Union, much less the executive and managing heads of the "greatest copper mine on earth."

The official list of principal shareholders given to the public at the meeting of stockholders, held during the latter part of April, 1911, for the year 1910, credited Manager Jackling with the ownership of 11,000 shares, whereas the corresponding list made public at THE RECENT ANNUAL MEETING, for the year 1911, gives him an ownership of only 5,868 shares, and that President MacNeill, at the same time, had succeeded in reducing his holdings from approximately 50,000 shares to 34,194 shares at the time of preparing the list of shareholders for the 1911 annual meeting, held on the twentieth of last month. Again, if we may indulge serious consideration of the substance of the reports of these gentlemen to the shareholders of the Utah company for the years 1910 and 1911, THE HASTE WITH WHICH THEY PROCEEDED TO DUMP THEIR HOLDINGS ON A DECLINING MARKET SEEMS ASTOUNDING.

It will be remembered that the report for 1910 showed that the developed ore reserves had been increased from about 92,000,000 tons to 202,000,000 tons, an increase for the year of about 110,000,000 tons. The average yield of copper per ton of ore for that year was given at 20.51 pounds per ton of ore treated. On the basis of alleged cost of production for the year 1911—7.865 cents per pound—this would yield, at the present price of the metal, 8c. net per pound of copper, or a little more than $1.70 per ton. The net value of this newly-found 110,000,000 tons of ore was therefore more than $187,000,000—a sum equal to about $123 per share upon the entire outstanding capital stock of the Utah company, BEING ABOUT TWO AND ONE-HALF TIMES THE PREVAILING MARKET PRICE during the time in which the president and manager unloaded their shares, as before mentioned.

It will also be remembered that for a couple of weeks prior to the giving out of the 1910 report (that is, about

April 28, 1911), quiet hints were industriously circulated from the local Utah office and by confidential brokers of the Utah company that A BIG SURPRISE was about to be sprung upon the investing public which would cause a rapid rise in the shares of the company; in fact, $150 a share was mentioned by the more zealous of the Utah company's subsidized press as likely to be reached when the impending disclosures should be made public. Many of the gullible ones dipped in for such number of shares as their resources would permit at prices ranging at or a little below $50 per share. But when the report came out it fell with a dull thud. Likewise the market price of the shares. Evidently the expectant public investor was greatly disappointed. Whether the quantity of newly-found ore was too small or whether its ponderous proportions rendered the fragile foundation insecure are matters for each loser to judge for himself. Certain it is that the price soon began to recede and floundered heavily between about $48 and $44 per share during the balance of the year.

Just what view Manager Jackling and President MacNeill took of the merits of their reports can best be inferred by the fact that they accepted the view of the general public and unloaded their shares, as before indicated.

An examination of the report of Manager Jackling in respect to the method or manner of discovery of the vast millions of tons of new ore discloses the fact that ONLY 1400 linear feet of DEVELOPMENT work had been done during 1910, and that the discovery was the result of THE CONSTRUCTION BY THE COMPANY'S DRAUGHTSMEN OF A SERIES OF NEW CROSS-SECTIONAL LINES upon the claim maps whereby simple mathematical calculations disclosed errors in previous calculations and provided a new constant which showed each previously known ton of ore to have EXPANDED sufficiently to cause it to occupy an area equal in capacity to a little more than two tons, as originally estimated.

This remarkable phenomena is doubtless due to the fact that all porphyries expand or "swell" on exposure to the atmosphere, a fact generally known but not always understood by the average mining engineer but which—owing to his long and diversified experience—was doubtless familiar to Manager Jackling, and which fact no doubt moved him to discredit the report and dispose of his shares, as before said.

Whatever may be the facts in respect to the process by which this vast tonnage was unconsciously made to appear to have been discovered, it is quite certain that the supposed discovery was a surprise to both Manager Jackling and President MacNeill, because a careful examination shows that neither of the four regular quarterly reports put out by these gentlemen to the stockholders of the company for the year under consideration DISCLOSED THE SLIGHTEST INTIMATION of the discovery or development OF ANY ADDITIONAL ORE during the entire period covered by the reports. And it can not be assumed that HAD such discoveries been made, the facts would have been kept concealed from the shareholders for the entire year and then an additional four months pending preparation of the report.

All that has been here said of the manner of discovery of additional ore and the probable cause that led thereto for the year 1910, applies with equal force TO THAT OTHER HUNDRED AND ODD MILLIONS OF TONS, the first appearance of any official knowledge of which occurs in the recent annual report of Manager Jackling, given to the public four months after the close of the year during which a discovery is alleged to have been made. In view of the characteristic swelling of these ores as suggested in respect to the enormous increase, due to that cause, during the year 1910, it is not surprising that the increase for 1911 should be as great as stated in the manager's report for 1911. In fact, it is a matter of surprise that the increase was not greater, as there was more known ore at the commencement of the year 1911 upon which this peculiar propensity could operate. Besides, THE SAME PROCESS OF RESECTIONIZING DIFFERENTIATION and ELIMINATION OF PREVIOUS ERRORS was applied as in the former case.

Now, in view of the greatly increased market price of and APPARENT demand for the shares of the Utah company, should Manager Jackling and President MacNeill take the same view of their report for 1911 as they did of that for 1910, they should be able—before the close of another quarter—to dispose of their remaining holdings at a very considerable advance in price over that which followed the promulgation of the story of the discovery of the first hundred million-ton increment. But, as the public is made to appear as having accepted the latest story in a more serious vein, possibly the manager and president of the Utah company may be influenced—even deceived—by public expressions, and in such case it will not be at all surprising to learn that they are reinvesting the proceeds of former sales in the same securities. Of course one can never be quite certain of the truth or falsity of reports of this character until they shall have become advised of the more deliberate judgment of the public, which just now appears to be on the bull side of the report.

WAYS OF FIGURING PROFITS

With isolated exceptions Mines and Methods has stood alone in its efforts to keep the public advised concerning the deceptions practiced by some of the big mining corporations—and particularly the greatest offender of them all, the Utah Copper Company—in dealing with their shareholders and the public. Elsewhere in this issue we reproduce an article on "Utah Copper Costs" that was written by Mr. Heath Steele, of New York, for the Engineering and Mining Journal. We commend it to the consideration of our readers because it deals with the subject in what is evidently an unbiased and unreproachful spirit and because it shows so plainly that, judged by the honest reports of corporations with which comparison is made, Mines and Methods has never been too severe in its criticisms of the methods of the management of the Utah company. We have contended all the time that Utah Copper has never earned the dividends it has paid. Mr. Steele, in his own way, makes it very plain that such is and has been the case. His argument should prove an inspiration to those who have been doubtful of the sincerity of the strictures of Mines and Methods, as it must prove a hard lump to swallow by those "financial" writers and market boosters who, either through blissful ignorance or personal gain, constantly employ dark lantern methods to discredit the utterances of Mines and Methods, but who lack the nerve to come out in the open and declare themselves.

Mr. Steele deals with only a few of the features of the recent annual report of the Utah Copper Company, which is the wickedest and most barefaced attempt yet made to bamboozle the public and create a broad market for its stock. There are a lot of things about it that will be discussed in coming issues of this magazine, but for the moment we shall content ourselves with giving our readers a chance to see that we are not alone in our opinions and estimates of those who control the destinies of the Utah company.

It is doubtful if any series of articles ever published on the subject of ore treatment has attracted as much attention as those by W. Lawrence Austin on leaching now running in Mines and Methods. Orders for issues containing these copyrighted articles come from all over the world.

FIGHT ON IN ARIZONA

‑cording to reports brought up from ‑nix, the Kinney bill, recently intro‑ ‑d in the Arizona legislature, now in ‑m, is causing some of the mine ‑gements to say things which, if ‑ do not quite jibe with the state‑ ‑s given shareholders in "official ‑ts" and brokerage market "dope." ‑of the chief objects of the Kinney ‑it seems, is to require mining com‑ ‑s not to employ men underground ‑do not speak and understand the ‑ish language. Early in the present ‑h the mining companies asked to ‑eard on the subject and, among ‑s who appeared before the com‑ ‑e to whom the bill had been re‑ ‑d was L. S. Cates for the Ray Con‑ ‑ated, B. Britten Gottsberger for the ‑i and Sherwood Aldrich for the ‑ration.

‑is not the purpose here to discuss ‑merits and demerits of the measure ‑red to, but we do wish to call at‑ ‑n to the manner in which some of ‑companies play fast and loose with ‑public. Cates' testimony brought ‑he fact that the Ray Consolidated ‑ an average of $2.25 per day to ‑ximately 2,000 employees. Judge ‑ley, one of the inquisitors, asked ‑Cates if he thought the proposed ‑would prove good or bad for the ‑ "Bad," said the witness. "Could ‑not afford to pay even $4 and still ‑ a profit at the Ray?" Mr. Cates ‑d with an emphatic "NO."

‑nager Gottsberger, of the Miami, ‑ied that the average wage paid by ‑mpany was $3.50 per day and that ‑of the men employed underground ‑ speak and understand the English ‑age. His company could pay such ‑e and make money because of the ‑ class of men and the greater effi‑ ‑y of the force. Asked if he did not ‑ the Ray ought to do equally as ‑ the witness replied that he was ‑tanding sponsor for the Ray.

‑re is the point we wish to make, as ‑s pointed out by Judge Worsley, ‑said to Manager Cates: "The liter‑ ‑, prospectuses and reports concern‑ ‑he earning value of your property ‑t bear out your statement. If what ‑ out to the world concerning your ‑rty is true, then your declaration ‑a $3.50 or $4 wage scale would pre‑ ‑ you from making a profit is un‑ ‑le," or words to that effect, as re‑ ‑ by the visitor from Phoenix to ‑city.

‑other words, the Ray Consolidated ‑for market effect, that it is now ‑ng, and preparing to earn, as each ‑month passes into history, dividends ‑would make the Count of Monte Cristo look like a pie-counter magnate, while its representatives declare—honestly, we believe—that if another six-bits a day was added to the wages of its men, making its scale the same as a neighbor's, it could not earn dividends. The real fault with Ray Con. seems to be that it has too much "probable ore" of as uncertain value as its "fully developed" churn-drill hole reserves.

Sherwood Aldrich, of the Inspiration, told the committee that the proposed bill would be bad for the state of Arizona, and he threatened that if it became law some $10,000,000 or $12,000,000 that was intended for invetment in Arizona would be diverted to Utah or Nevada. If that is the case, Utah ought to send a delegation down to Phoenix to work for the passage of the Kinney bill.

AS LIKE AS TWO PEAS

A London expert who was sent to report on a mine in Gilpin county, Colorado, tells the shareholders that "the positive ore developed amounts to 135,545 tons of an average assay value of $9.35 per ton. The probable ore amounts to 95,025 tons of an average assay value of $9.22 per ton. The ore expectant amounts to 220,082 tons of an average assay of $9.22 per ton." Note the 22c! It is a well known fact that a metallurgist and mining engineer in that state, estimated to within a few cents per ton what it would cost to mill an 800,000-ton dump, and within a few dollars of how much profit per month he could extract in two years—and subsequently did it. But the other totally eclipses this—on paper—and knocks into a cocked hat the old adage "you cannot see an inch ahead of your pick's point." It simply shows what marvelous advance science is making in the art of mining when the value of 315,107 tons of "probable and expectant ore" can be given within a cent to the shareholders expectant.—By the Way item in Engineering and Mining Journal, May 4, 1912.

The above item is reproduced in order that we might tack on a paragraph from General Manager Jackling's report to the "expectant" stockholders of the Utah Copper Company, wherein it deals so minutely with the value of the "partially developed" ore, as follows:

"After deducting all the ore that has been mined from the property previous to January 1, 1912, there yet remained 301,500,000 tons of fully developed and partially developed ore, of which amount 229,830,000 tons were fully developed and 71,670,000 tons partially developed. The above-mentioned developed ore includes about 26,970,000 tons of partially developed ore in the slopes of the steam shovel workings. Of the fully developed ore, the average assay of 62,040,000 tons is 2 per cent copper; the average assay of an additional 92,130,000 tons is 1.6 per cent copper, and the average assay of the remaining 75,660,000 tons is 1.3 per cent copper. The average assay of the 71,160,000 tons of PARTIAILY DEVELOPED ore is 1.28 per cent, making the average of 301,500,000 tons of developed and partially developed ore 1.532 per cent copper.

WOULD "JOLLY" INVESTORS

Mines and Methods has often stated that—notwithstanding all the declarations of the insiders and the subsidized prattle of the daily press and the "financial" and market publications of the east that copper metal was nearly all consumed and that a broad market had developed for "porphyry copper" shares as a result—THE PUBLIC was not loading up with these offerings to any appreciable extent. There is some measure of satisfaction in having the Herald-Republican of this city build a goodly portion of its articles dealing with the visit of the great Eastern banking interests and copper magnates by quoting "a man whose interests have kept him in close touch with the mining world of New York and Boston," and making him, among other things, say:

"The copper situation has been unsettled for years; the public has not been investing in the copper stocks offered by these great banking institutions, and on each advance in the market those holding copper stocks HAVE BEEN UNLOADING ON THESE BANKING INSTITUTIONS. It has been suggested that this trip was for the purpose of assuring these men who have been supporting the market and taking the stock off from the brokers' hands for several years, of the merits of the properties and the stability of the investments made; and that these men, through a 'gentlemen's agreement,' after seeing the properties, GIVE SUFFICIENT FINANCIAL SUPPORT TO MAINTAIN THE MARKETS and produce the money for the SUPPORTNG OF THE COPPER METAL PRICE, and the bringing about of a more prosperous condition in the stock market THAT THEY MIGHT RECEIVE RELIEF IN CARRYING THE STOCKS THEMSELVES, and DISTRIBUTING THEM AMONG THE INVESTING PUBLIC by ASSURING IT that the properties ARE meritorious and justify the investment. (Capitals are ours.) * * *

"It is believed that when these men report the situation as they found it, the entire investing public will not only have more confidence in the copper market, but will have more confidence in the general business institutions of the country. * * * It is significant, indeed, that the great Standard Oil and Guggenheim copper interests are meeting here in Utah * * * with the hopes of (making a) distribution of stocks to the public AND RELIEVING THEMSELVES OF THE VAST AMOUNT OF STOCK THAT THEY HAVE BEEN FORCED TO CARRY. * * *."

From this frank statement it might be also inferred that these great banking interests, while expiating on the merits and tremendous value of these copper stock investments, are standing in together with a well-defined purpose of doing the dear public a fine turn by trading to them reams of gilt-and-gold "securities" for real coin of the realm.

A COMPARISON OF UTAH COPPER COSTS

By HEATH STEELE.*

The Utah Copper Company in its annual report states that it produced copper for 8.07c. per lb. in 1910 and 7.87c. in 1911. In summing up the copper situation in his report to the state of Michigan in 1911, J. R. Finlay, in reference to the porphyry copper mines said: "So far as costs are concerned, the porphyry mines are in essentially the same condition as other mines. Some can produce copper cheaply and others cannot. It is highly doubtful if their average cost will even be as low as in the Lake Superior district." The average cost of production in the Lake district during the five-year period 1906-1910 was 10.1c. per lb. for all the profitable mines. The Utah Copper Company claims that the cost figures reported cover costs of every kind and description, but before it is fair to compare any two cost records it is only fair to see if the figures given to each represent the same costs. It is the custom in the Lake district to charge every expenditure to operations. Their reports are by far the most satisfactory statements issued by any of the American mining companies; the total receipts and expenditures are itemized so that one can see at a glance the profit or loss for the year. No attempt is made to defer charges. Let us take two of the mines in this district as examples, the Calumet & Hecla, a mature property; and the Ahmeek, a new one.

During the five years mentioned it cost the Calumet & Hecla 8.95c. per lb. to produce 410,614,189 pounds of copper from 13,185,376 tons of rock averaging 31.2 net pounds of copper per ton. The total cost was $36,662,696, made up as follows: Mining, transportation and milling, $26,850,772, $2.04 per ton or 6.54c. per pound of copper; construction, $2,889,570, or 0.74c. per pound; smelting, refining and commissions, $4,684,975, or 1.14c. per pound; and general expenses, $2,237,379, or 0.53c. per pound of copper. It must be borne in mind that these figures represent every expenditure during this period, so that the total cost as given, substracted from the gross receipts, $61,313,175, leaves the actual net profits, $24,650,479; therefore there is no disputing the reported cost of production, 8.95c. per pound.

The Ahmeek Mining Company produced 35,911,797 pounds of copper, during the same period, from 1,722,281 tons of rock, having a net yield of 20.9 pounds per ton at an average cost of 13.3c. per pound of copper. But like the Calumet & Hecla figures, this cost includes all expenditures, which were partly absorbed in equipping the property, as will be noticed by the construction item in the costs herewith: Mining, transportation and milling, $3,002,075, or $1.74 per ton of rock, or 8.36c. per pound pound of copper; smelting, refining and commissions, $411,804, or 1.15c. per pound; construction, $1,226,945, or 3.42c. per pound; and general expenses, $145,192, or 0.40c. per pound of copper. The total expenditures were $4,786,018, which, substracted from the gross receipts, $5,134,777, gives the actual profit, $348,758 for the five years. In the case of the Ahmeek the cost will be lower in the future owing to a reduction in construction at the property; in fact, the cost reported for 1911 was 7.17c. per pound but the amount spent during the year for construction was much below the average required for the Lake Superior mines 0.8c. per pound of copper. It seems safe to say in regard to the future costs, that if the yield is maintained at the present amount and construction figured at the average cost, Ahmeek will produce copper at a cost of 7.5 to 8c. per pound with a certainty of an increse if the yield falls below the present amount.

The Utah Copper reports are elaborate and give many figures, but it cannot be said that they are plain to the average layman who tries to figure out the net results. It is a large property and owing to various investments and holdings the accounts are necessarily numerous; however, let us see what its costs would be in the plain language of the Lake Superior copper-mine reports.

For 1910 the report gives the operating expenses as $7,819,477, for a production of 84,502,475 pounds of copper from 4,340,245 tons of ore yielding 19.5 pounds net of copper per ton. This indicates a cost of 9.25c. from which 1.18c. per pound is deducted for gold and silver, making 8.07c. per lb. as reported. But if this figure is to be compared with the Lake Superior costs let us look further into the figures reported. We find that the operating expenses as reported include $272,675 for "prepaid expense-ore stripping" but in addition to this item as charged to operation, there has been a further expenditure of $1,022,967.34 for stripping and an additional sum for improvements and equipment charged to property account of $822,170.58. Add these two amounts to the total operating expense as reported and we have a total of $9,664,614.82, which makes the total cost of copper 11.49c. per pound, and deducting 1.18c. for gold and silver leaves an actual cost of 10.31c. per pound instead of 8.07c. as reported.

The 1911 annual report, just published, states that 93,514,419 pounds of copper were returned by the smelters from 4,680,801 tons of ore yielding about 20 pounds net per ton at a cost of $8,324,053 or 7.87c. per pound after deducting 1.07c. for gold and silver credits. The operating cost reported includes $351,060 for stripping ore, but like 1910 there was an additional amount spent, $1,628,766, for the same item, but charged to deferred account. If we add this amount and $1,215,121, which was spent for improvements and equipment as charged to capital account, as well as $30,966 for interest paid but deducted from miscellaneous earnings, we have a total expenditure of $11,198,905.75 for the year. We then have a cost of 11.94c. per pound and after deducting gold and silver credits, 10.87c. per pound instead of 7.87c. as reported. It will be noticed in this report that $2,500,000 of the stripping expense which in the past had been charged to deferred accounts, was charged to profit and loss account this year. In this way this sum will never appear in the report as an operating cost where it belongs. It is plain to see that the claims of 8c. costs have not been actually realized at the Utah Copper and are nothing more than estimates of hopes for the future, and are obtained at present only by deferring to some future date charges that may or may not be charged off at present in the correct proportion to the tons of ore produced. The fact that such a sum has to be charged off through profit and loss certainly leads to the inference that it has been found necessary to allow more than has been charged through the operating cost statements.

In regard to construction and equipment expenses, it must be remembered that these charges are inevitable and will continue to be a large item as long as the property operates. For example, the Calumet & Hecla figures given above, show that it has cost this mine 0.74c. per pound of copper or 7.86 per cent of the total expenditures during the five-year period. In the case of the Utah Copper the amount charged to capital accounts for construction and equipment in 1910 was 8.5 per cent of

*In Engineering & Mining Journal, May 11, 1912.

the total expenditures or 0.97c. per pound of copper; and in 1911, 10.8 per cent of the total or 1.29c. per pound of copper. The Calumet & Hecla current-construction expense represents about the average of what it has cost all the Lake Superior mines for the same expense.

If we reconstruct the figures of the Utah Copper Company's report in this way the operating profits are materially different from those reported in the 1910 and 1911 annuals: $5,401,775 and $6,227,928 respectively. In 1910 the operating revenue was $11,710,389; deducting the total expenditures for mining, milling, transportation, construction, improvements and stripping as stated, $9,664,615, the net operating profits will be only $2,045,774. The revenue from investments, etc., amounted to $1,510,863, making a total net revenue of $3,556,637, out of which was paid a dividend of $4,648,676, a deficit of $1,092,038 for the year.

In 1911 the operating revenue was $12,825,953, from which deduct $11,198,906 for expenditures and the operating profit is $1,627,047. The income from investments, etc., amounted to $1,766,995, making a total net revenue of $3,394,042, out of which a dividend of $4,703,022 was paid, leaving a deficit of $1,308,980 for the year. This makes a total of $9,451,698 paid in dividends in the last two years out of a total net revenue of $6,950,679, or an excess of $2,501,018 over revenue. During 1911 the current assets were reduced $2,030,753. The figures stated do not include any investments made by the company in various enterprises. It should be perfectly plain to any one that these figures must be reconstructed in this way if they are to be compared with the copper mines of Lake Superior carrying no deferred charges. The stripping that has already been done will surely yield more ore than has been taken from the pits but it is a question whether the operation of the mine can be continued from year to year with a less amount of stripping. An important fact in connection with this question is, that to increase the tonnage production 7.84 per cent in 1911 over 1910 it was necessary to increase the underground proportion 8 per cent—from 18 to 26 per cent of the total tonnage. If this mens that any further increase in output will have to come largely from the underground workings it certainly does not argue that the cost of mining and stripping will be lowered.

Marcasite has the same composition as pyrite, but is distinguished by its crystallization and lighter color.

UTAH COPPERETTES

Governor Spry's Ryan banquet speech: "When Jackling runs for governor of Utah we'll all vote for him." Of course the governor only had reference to those at the banquet for whom he could vouch.

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It is not considered "good form" to joke about copper stock market conditions and for that reason one Thomas C. Shotwell, who daily discourses on the New York market for a local paper should be suppressed. His guff about the "fundamental" and "statistical" position of the market and the red metal would start the risibilities of a "houn' dawg." The copper stock market is just as "strong" as the big banking interests, who at the present time are "holding the sack," care to make it—no more, no less.

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An evening or two before the arrival of the John D. Ryan party, which inspected the mines of the Utah Copper Company, blasting along the steam-shovel slopes was so heavy and lasted so long that hundreds of people in Salt Lake began to get nervous; they could not imagine what it all meant. It was done, of course, to properly impress the visiting easterners with the tremendous magnitude of the operations. This feature of the visit will be better understood by the Bingham Press-Bulletin's statement that "for the benefit of the visitors the shovels were CONCENTRATED so that the bigness of the undertaking could be better demonstrated."

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In its main story of the magnificent banquet given by Colonel D. C. Jackling to the John D. Ryan party at the Hotel Utah on the evening of May 1, the Herald-Republican says: "Every precaution was taken to prevent the party from being disturbed by intruders and at the entrance to the grill room Police Inspector Carl A. Carlson, Sergeant E. V. Johnson and Sergeant Thomas Simpson stood guard."

Wonder what sort of an intrusion Colonel Jackling feared? The dissipation of the awful suspense by the fall of the curtain without an unwelcome guest (ghost) of any kind having eluded the vigilance of the sleuths on guard must have lifted a great strain from the colonel's peace of mind.

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The Salt Lake Herald-Republican of the 20th editorially relates that "an enterprising western journal has uncovered some interesting answers to questions in a public school examination," the following among the rest: "King Henry VIII, mostly by his own efforts, increased the population of England 40,000." In its comment the local paper says: "Take the one about Henry VIII. The only trouble with it seems to be that the total is a little high."

While extolling the virtues and abilities of Colonel Jackling at the Ryan party reception Governor Spry said, according to the Herald-Republican: "He (Col. Jackling) came amongst us unknown, but in a short period made his personality felt, and he has since been directly responsible for adding at least 25,000 people to the population of Salt Lake county." Like the case quoted in the first paragraph of this item, it is urged that the only trouble with the governor's estimate "seems to be that the total is a little high."

SILVER KING DEAL ON

According to the news that has sifted through from inside sources and which has been a subject for discussion in well-posted mining circles for several days past, it seems that negotiations are well along in a deal which, if it is finally consummated, will involve the sale of the Silver King Coalition company's mines at Park City to one of the most powerful foreign exploration companies in the world. Details of the undertaking can not be announced at this time, because of their tentative character, and it is probable that the daily press will find time enough to leave its forlorn copper stock boosting campaign long enough to have covered this piece of real news before the appearance of the June issue of Mines and Methods, a month hence.

About three weeks ago Mr. O. O. Howard, representing the foreign corporation referred to came to Salt Lake for the purpose of meeting the chief interests of the Coalition company and having them place a price on the famous Park City mines. Dickering has been in progress ever since and it was stated Monday that negotiations had reached a stage where, on compliance with certain conditions, the examination and sampling of the mines might be commenced by Mr. Howard.

The price named has, of course, not been released, but it is safe to say that the property, which has paid nearly $12,500,000 in dividends already, and which is declared to be now in better physical condition than at any time in the past, will call for the dislodgement of several millions of dollars on the part of the purchasers if it is secured. The prospective sale is of intense local interest because practically all of the stock in the Coaliton company is owned in Salt Lake and Utah.

LEACHING APPLIED TO COPPER ORE* (XVIII)

ELECTROLYTIC DEPOSITION OF COPPER FROM SOLUTIONS (CONTINUED)

By W. L. AUSTIN.†

In the preceding article the deposition of metallic copper from a neutral sulphate solution by means of an electric current generated through dissolving metallic iron in the same bath, was considered wholly from a theoretical standpoint. Iron anodes and copper cathodes were assumed to be hung in a solution of copper sulphate, and these were short-circuited at the top out of reach of the liquor. This was simply an improved arrangement of the ordinary features of cementation, and it was demonstrated by thermo-chemical data that in this manner one pound of iron should theoretically deposit 1.1 lb. copper. However, a simple laboratory experiment will show that this process does not proceed in the manner indicated. Spongy copper separates out at the anode in large quantity and the voltmeter registers a very weak EMF (electromotive force=potential).

Richards in "Metallurgical Calculations," Part III, page 523, states: "If iron in plates or sheets, or bundles of scrap iron in a crate or holder are immersed in copper sulphate solution and simultaneously connected electrically with a copper plate to serve as cathode, no copper precipitates on the iron, but all is precipitated on the copper. The iron acts as a soluble anode, going into solution as ferrous sulphate, while the copper is deposited out passive, dense, and practically chemically pure on the cathode sheet." The writer has not succeeded in obtaining experimentally the result indicated, when using a neutral solution of commercial bluestone, equivalent to 5% $CuSO_4$. Employing electrodes such as described in the foregoing, the current produced is very weak and the voltmeter shows less than half a volt. The greater part of the copper deposits on the iron anode. When crystals of pure copper sulphate dissolved in distilled water constitute the electrolyte, much better results are obtained. The solution is wholly decoppered and most of the metal is deposited on the cathode, but some still adheres to the iron. There is a very marked difference between tests made with chemically pure reagents and those carried out when using commercial products. The latter, of course, more nearly approximate working conditions. When a very little free acid (one part acid to 300 parts water) is added to the commercial sulphate solutions, the action becomes much stronger, but hydrogen gas is evolved and much copper separates at the anode in a flocculent state.

An explanation of this phenomenon might be as follows. In all galvanic cells which produce electric current, the source of electric energy is chemical action. This is demonstrated by the fact that after such cells have been in operation a sufficient time for chemical exchange of elements to take place, the cells exhaust themselves and current ceases to flow. Among metals which decompose water in the presence of an acid, is iron. If metallic iron is placed in weak sulphuric acid the water is decomposed, iron going into solution and hydrogen gas being given off. If instead of acid a solution of copper sulphate is taken, then the iron also goes into solution but no hydrogen gas appears. At least this is the case when the experiment is made using wrought iron: when cast iron is substituted the result is different, because of the carbon contained in the cast iron which forms with Fe a strong galvanic couple. A piece of cast iron when joined by a conductor to a piece of copper will cause a voluminous evolution of gas from a copper sulphate solution in which wrought iron will corrode without any appearance of gas.

SOLUTION PRESSURE.

When a metal is brought in contact with water a force is developed which tends to drive the metal into solution. This so called solution-pressure varies with different metals. Iron and zinc have a greater tendency to dissolve in a copper-sulphate solution than is the case with copper, therefore these two metals when immersed in a copper-sulphate bath crowd out the copper and take its place. That copper is reduced from a neutral copper-sulphate solution through the greater solution-pressure of the iron, and does not owe its reduction to hydrogen gas, is shown by the fact that when wrought iron is used there is no hydrogen gas evolved; and by the further fact that hydrogen gas can be passed through another portion of the same solution indefinitely without copper being reduced to metallic form.

When a galvanic couple such as iron-copper is placed in a neutral solution of copper-sulphate, the reactions which occur indicate that two distinct operations are in progress. In the first place, because of superior solution-pressure, iron is dissolved, whereby an equivalent amount of copper is precipitated at the anode. This copper detaches itself and collects at the bottom of the vessel. Under certain conditions hydrogen gas is given off from the pile, indicating that the precipitate is not alone copper, but copper alloyed with hydrogen. As ferrous sulphate is formed through corrosion of the iron, and as this salt in dilute solutions is readily hydrolyzed, (separated into basic ferric salts and acid), there soon appears a cloudiness in the liquor and the anode is attacked. Chemical action of acid on metallic iron produces EMF, or difference of potential between two electrodes, resulting in deposition of copper on the cathode when the electrolyte is a solution of copper sulphate. The anode-copper is sometimes flocculent, sometimes firmly adherent, according to conditions under which the experiment is carried out. EMF is also developed through action of ferric sulphate on an iron anode. Ferric sulphate forms rapidly in the liquor through absorption of oxygen from the air, and this salt dissolves iron, so that an electric current would be set up between short-circuited electrodes even were no acid formed through hydrolytic dissociation.

Another way of accounting for deposition of copper on the iron is, that as all forms of commercial iron contain more or less carbon, there must be portions of the surface even of a wrought-iron anode where minute quantities of carbon are present. Between the small particles of carbon and the adjoining iron, galvanic currents will develop, which in turn precipitate particles of copper from the enveloping liquor. Once metalic copper appears in proximity to the anode, innumerable short-circuited galvanic couples are established and more copper comes down. As the resistance of the electrolyte between the electrodes of the battery

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is very considerable, only a portion of the copper is deposited on the cathode, while action between the short-circuited couples at the anode is correspondingly vigorous. The outcome of the operation is, voluminous deposition of copper-hydrogen at the anode, a small quantity of electrolytic copper on the cathode, and a weak electric current through the outside circuit. In any event, whatever the explanation, when copper is precipitated from a sulphate solution by means of a short-circuited galvanic couple composed of iron and copper, the electrodes being spaced five centimeters apart, the metal is deposited at two points.

The fact that copper is deposited on both electrodes does not of itself nullify the result derived from thermo-chemical calculations. That portion of the copper which separates out at the anode should necessitate the corrosion of a lesser quantity of iron than would be the case were an equivalent amount of metal deposited as cathode-copper, because the EMF necessary to overcome the resistance of the 5 cm. of electrolyte which separate the electrodes is diverted instead to metal deposition. The main disadvantage of anode precipitation lies in the flocculent condition of the copper which is easily adulterated through admixture with basic ferric salts. It is in fact cement-copper and not pure cathode copper.

CALCULATED VS. WORKING RESULTS.

A point which should never be lost sight of in considering theoretical estimates of the amount of power required to carry out any electrolytical operation is, that there always exists a great difference between calculated results and those obtained in actual work. For instance, in copper refineries if 62 per cent of the calculated energy required is profitably employed, the result is considered satisfactory—that is, in estimating the power requisite for a given electrolytic refinery, an allowance of 61% above the theoretical quantity must be made. There are many opportunities for current to go astray, and since the liquors invariably contain mixed salts the quantity of metal separated is not proportional to the quantity of electricity passed through the solution. Especially the last traces of metal in solution require large excess of current to effect complete precipitation.

Returning to consideration of the subject under discussion, (the precipitation of copper from liquors by means of a galvanic couple), even if metal is not wholly deposited on the cathodes by current set up through corrosion of iron, still there seems to be room for improvement over existing wasteful methods. As pig-iron is largely used in the cementation process, it would seem practicable to cast such material in the form of rough anodes, and to suspend these in suitable vats together with copper cathodes, at the same time short-circuiting the electrodes. A great economy could be affected by excluding air from the vats, for if that were done copper could be precipitated with the minimum production of ferric salts. The ferric salts corrode as much, or more, metallic iron than is used in precipitating the copper. The tower system of precipitation in use at Butte is particularly wasteful of iron because allowing the liquors to fall in a shower over scrap-iron placed in racks, affords the best opportunity for the formation of ferric salts.

The atmosphere can be excluded from precipitation vats by covering them, which would result in the oxygen of the enclosed air being soon exhausted, leaving only inert nitrogen. In experimental work a sheet of oil has been poured on the surface of the liquor, which expedient answered very well for the purpose of preventing excessive oxidation. Whichever method of air-exclusion be adopted, liquors can be made to circulate through a series of vats until practically all the copper is removed, yielding precipitate fairly free from basic ferric salts, together with some pure cathode metal, and in this way the efficiency of the cementation process can be materially augmented. However, some basic salts are sure to form owing to hydrolytic dissociation which takes place even when air is excluded by using oil. Should oil be employed to prevent oxidation, it would only be necessary to draw off the oil-covering from such vats after the anodes had been consumed, and this could be done through plug-holes placed in the sides of the vats. If unnecessary corrosion of anodes can be prevented by exclusion of air, then with cast-iron anodes costing one cent per pound it should be possible to deposit copper partly as cathode metal, partly as cement, for approximately one cent per pound also.

So far the electric current generated by corrosion of the iron of an iron-copper galvanic couple has been alone considered. It is obvious that this primary current can be supplemented with current generated by a dynamo, which can be made to pass through the vat in the same direction as that flowing from corrosion of the iron. Richards (loc. cit.) also supplies an illustration of a case of this kind. He assumes an arrangement of 100 vats, all similar to the one described in the foregoing. These vats are supposed to be arranged in series, the anodes of each vat connected as one large anode, and the cathodes similarly coupled up as one large cathode. The dynamo used is considered capable of maintaining a pressure of 110 volts across its terminals. The bus-bars for conducting current are one by four centimeters in cross-section, and have a total length of 280 meters.

Now the resistance offered to the passage of an electric current by a copper wire of one square millimeter cross-section, and one meter in length, at 18° C., is 0.0175 ohm, therefore the total resistance of the bus-bars referred to in the last paragraph will be 0.01225 ohm. For as resistance to a given current decreases with cross-section of conductor, and as one by four cm. = 400 sq. millimeters, therefore the resistance of one meter length of the bus-bars will be one four-hundredth of what it would be for 1 sq. mm., and for 280 meters length it will be 280 times as much = 0.01225 ohm.

It was shown in the previous example that the theoretical resistance offered by a single vat, with electrodes as described and using a pure copper-sulphate solution, would amount to 0.0026 ohm, therefore the resistance which the current would have to overcome in traversing 100 such vats under similar conditions would be 0.26 ohm. Similarly a loss of 0.1 volt per vat, due to connections, would amount to $\frac{0.1 \text{ volt}}{296 \text{ amp.}} = 0.000337$ ohm, or 0.0337 ohm for the series of 100 vats. Adding the resistances of the external conductor, the electrolyte, and the connections, gives a total resistance for the whole series of 100 vats amounting to 0.306 ohms. This would be the theoretical ohmic resistance at the start, when the bath holds five per cent $CuSO_4$; but as copper is deposited on the cathode its place is taken by iron, and the ferrous sulphate formed has a greater resistance than copper sulphate. So, as a matter of fact, the resistivity of the liquor will be steadily increasing as deposition of copper proceeds, and in consequence flow of current will also decrease and less copper will be deposited in 24 hours than the estimate based upon quantity of copper sulphate originally contained in the solution would indicate.

The theoretical difference of potential between the electrodes of an iron-copper couple produced by corrosion of the iron was found in the former illustration to be 0.87 volt: therefore in 100 vats it should amount to 87 volts. Without admitting the correctness of these figures they will be taken in order to make the calculation comparable with the former example, and adding these 87 volts to the 110 generated by the dynamo would give a total operative electromotive force of 197 volts. As the quantity of copper deposited from a bath is determined

by the number of amperes of current flowing through it, and as current equals voltage divided by resistance, therefore $\frac{197}{0.306}$ = 644 amperes multiplied by the number of grams of copper deposited by one ampere in twenty-four hours will give the productive capacity of a single vat. Assuming the theoretical amount of copper deposited in 24 hours by one ampere (28.416 grams), there would be deposited in the whole 100 vats 28.416$\times$644$\times$100=1,829,706 grams of copper.

COMPARATIVE COST OF IRON AND CURRENT.

It is interesting, with the help of the data derived from the above calculation, to ascertain the effect of current obtained from the dynamo upon the cost of depositing copper with the arrangement cited. In the first example it was found that 7608 grams of iron in corroding deposited in 24 hours 8411 grams copper in one vat. It was also determined from the second example that with the help of the dynamo 18297 grams were deposited in the same time. At the ratio of deposition as established in the first example, to deposit 18297 grams of copper without the dynamo would call for the corrosion of 16550 grams iron, therefore the work done by the dynamo is represented by 16550 — 7608 = 8942 grams iron. As the dynamo is assumed to give a pressure of 110 volts across its terminals, and as the resistance of the total circuit has been estimated at 0.306 ohms, the current derived from this source should be $\frac{110}{0.306}$ = 360 amperes. As the operation is assumed to continue for 24 hours, the quantity of current delivered by the dynamo should be 360$\times$110$\times$24=950 kilowatt-hours. At one cent per kilowatt-hour there would be an expense of $9.50 distributed over 100 vats, so that the work done by the dynamo in one vat would be represented by $0.095. On the other hand, 8942 grams iron correspond to 19.7 lb. avd., and this at one cent per pound would represent an expense of $0.197. If, therefore the dynamo current were replaced by one developed through corrosion of iron, at the prices quoted the expense would be slightly more than doubled. If iron cost half a cent per pound, and the kilowatt-hour two cents, then the relative expense would be reversed. There would be an advantage in using dynamo-current because by that means cathode-copper would be produced, and not so much cement as in employing iron. It is evident, therefore, that attaching a dynamo to cementation vats might under favorable circumstances have some advantage.

If an electric current from an external source is made to traverse an electrolyte, the electrodes used may be either soluble or insoluble in the solution. It has been shown in the foregoing calculations that when the anode consists of a metal which has superior electrolytic solution pressure to that of the metal contained in the salt to be electrolyzed, is, in other words, a soluble anode, and the anode metal is capable of replacing the one in solution, then the current flowing through the bath will be augmented. Heat units will be liberated at the anode when the metal forming that electrode corrodes, and heat units will be used at the cathode in freeing the metal deposited from the electrolyte. The ratio of heat units liberated to those consumed is a measure of the auxiliary current developed by corrosion of the anode.

If the metal composing a soluble anode is the same as that liberated at the cathode, as in electrolytic refining of converter-copper, then the energy generated by solution should be theoretically precisely the same as that consumed by deposition on the cathodes. The one should off-set the other. When, however, the anode is composed of a substance not affected by the components of the electrolyte, or by the products of electrolysis, then the current traversing the bath is called upon to do work without receiving compensation from corrosion of the anode, and the energy expended is correspondingly greater. It requires more power to electrolyze a copper-sulphate solution using insoluble anodes than when others soluble in the bath are employed.

In electrolyzing a copper sulphate solution using insoluble anodes copper will be removed from the bath and sulphuric acid will be produced. To form, therefore, an approximate estimate of the energy required to carry out such an operation, recourse must again be had to thermal chemistry. Liquors which might be used for electrolysis would probably be derived from ore-leaching, and therefore would contain other salts in addition to copper sulphate. These would bring about various complications, according to their chemical nature and relative concentration in the liquor. For instance, with iron salts present ferric sulphate would be produced at the anode, and this reagent would be carried by diffusion to the cathode where it would redissolve the deposited copper. Accordingly in such work it is necessary to keep the anolyte separated from the catholyte by means of a diaphragm, and diaphragms are difficult to maintain and also offer resistance to the passage of the current. It is not practical to deposit metal from a bath at one electrode, and at the same time to generate a solvent for that metal at the other electrode, without interposing a diaphragm. It has been a
to treat mine-waters by electro
consumption of current was fou
so great that the operation pres
advantages over cementation wi
iron.

ELECTROLYSIS WITH INS
ANODES.

In electrolyzing a bath of co
phate using insoluble anodes
copper is deposited on the catl
phuric acid collects in the el
and oxygen is evolved at the an
estimate the EMF required it
fore necessary to ascertain the
of heat-units involved in libera
per at the negative electrode
gen at the positive. Also th
developed through the formatic
phuric acid. By reference to
thermo-chemical data it will be
such a case that 124,320 cal
absorbed in freeing copper and
The notation adopted in therm
istry for representing reactions
trated by the following:

[Cu, O, SO^3aq]=55,960
[H^2, O] =68,360

124,230 calories co

In a similar manner it can
that the formation of sulphuri
the transformations under cons
developes 68,360 calories. The
between the two amounts r
heat-units which it is necessar
ply in carrying out the reacti
result is 55,960, which numb
to one gram molecule of cop
rated. Now one ampere of curr
ing for one second at one volt
(one volt-coulomb), will devel
calories and 96,540 volt-coul
the amount of current req
separate a gram-equivalent
univalent element. Copper
as sulphate is bivalent there
half the amount represented
atomic weight will be
by 96,540 volt-coulombs, and
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ly necessary to deposit that
of bivalent copper it is necessa
tiply the stated number of
lombs by 0.2387 which gives 2
the above calculation it was sh
55,960 calories had to be su
separate one gram molecule o
copper, or 27,980 cal. for hal
molecule. As one volt corres
about 24,046 cal., it is only nec
divide 27,980 by this number
to find the minimum number
required to electrolyze a solutic
per sulphate, which is 1.214 vo

In electrolytic refineries t
sometimes become too rich i
and too poor in acid. To re
condition the solution is draw

electrolyzed in special cells, using insoluble anodes (lead). This is practically the same operation as the one under consideration, only the liquor is much richer. The EMF necessary to electrolyze such a bath varies between 2.0 to 2.5 volts, but this includes all the resistance encountered by the current. These figures afford a means of comparing theory with practice.

As to the energy consumed in overcoming resistance of the bath when electrolyzing a weak solution of copper sulphate, let it be assumed that the liquor contains 0.08 percent $CuSO_4$. Such a content is said to be 0.01-normal. Under a normal solution is understood one in which the molecular weight of a salt, stated in grams, is dissolved in one litre of solution. For example, a normal solution of chloride of potassium (KCl) is one holding 74.6 grams KCl in one litre of solution. In comparing the conductivities of different electrolytes, solutions are taken which contain an equal number of gram-equivalents (not molecules). A gram-equivalent is the formula-weight in grams divided by the number of electro-chemical equivalents which are necessary for its complete decomposition. Under electro-chemical equivalent is understood the quantity of electricity associated with a gram-equivalent of a univalent element—that is, 96,540 coulombs = 1 Faraday. While a normal solution of chloride of silver is one containing $\frac{107.93}{1} = 107.93$ grams AgCl, because silver is a univalent metal, a normal solution of copper sulphate contains $\frac{158.47}{2} = 79.23$ grams of that salt—that is, it requires two Faradays to completely decompose a molecular weight of that substance represented in grams per litre of solution. A bath containing 0.08 per cent $CuSO_4$, or more exactly stated 0.0798%, would have one hundredth part of 79.23 grams, and is, therefore, 0.01-normal.

If now the resistance of one cubic centimeter of 0.01-normal copper sulphate solution at 18°C. be 1394 ohms, and the electrodes are placed three centimeters apart, the resistance of the electrolyte in one vate would be 4182 ohms. If the current density is 20 amperes per square meter, which is equivalent to $\frac{20}{10,000} = 0.002$ amps. per sq. cm., then the theoretical EMF necessary to overcome resistance under conditions specified would be (current= $\frac{\text{EMF}}{\text{resistance}}$) $4182 \times 0.002 = 8.4$ volts. The total voltage absorbed at the start in overcoming resistance of the electrolyte would be 8.4 volts. Adding this EMF to that determined above as requisite to deposit metallic copper on the cathode (1.214 volt for one vat), the voltage across the electrodes would be $8.4 + 1.2 = 9.6$ volts. Including 0.2 volt absorbed by connections and contacts at each vat, the total EMF necessary to drive current through one vat at the start would be 9.8 volts.

The result given applies to a 0.01-normal solution, that is, to the solution present in the vats when the operation commences. As electrolysis proceeds copper is removed and sulphuric acid accumulates, and the acid being a better conductor than the copper salt, the resistivity of the bath diminishes progressively. This is well illustrated by the tables given in Mines & Methods, Vol. II, pages 282-284. Finally the 0.01-normal $CuSO_4$ solution becomes 0.01-normal H_2SO_4. Taking the resistance of one cu. cm. of 0.01-normal H_2SO_4 solution at 325 ohms, the three centimeters between the electrodes would offer a resistance of 975 ohms, and the EMF necessary to overcome the resistance of the electrolyte would be $9.75 \times 0.002 = 1.95$ volts. Therefore when depositing the last vestiges of copper from the bath the EMF required would be $1.95 + 1.21 = 3.16$ volts.

The average resistance offered by the electrolyte to a given operation will not be the arithmetical mean between the two extremes, because the conductivities of solutions do not diminish in proportion to their strength. For instance, the resistance offered by one cu. cm. of fifteen per cent $CuSO_4$ solution is 23.8 ohms, whereas that of a five per cent solution is 52.9. At the same time that copper content of the bath decreases, that of the H_2SO_4 increases, rendering conductivity very much better. The resistance of one cu. cm. of 15% H_2SO_4 solution is 1.8 ohms; of a 5% solution, 4.8 ohms. In the case at point, if the average voltage absorbed in overcoming the ohmic resistance through the electrolyte be taken at 3.52 volts for the total circuit, the electromotive force absorbed would be:

In depositing copper	1.21
Resistance of electrolyte	3.52
Loss in contacts	0.20
Total, volts	4.93

Assuming that the current traversing the vats amounts to 300 amperes, there will be consumed $4.93 \times 300 = 1,479$ watts $= 1.479$ kilowatts. As one ampere-hour deposits 1,186 grams of bivalent copper, 300 will deposit 355.8 gram in each vat in one hour. The output per kilowatt-hour would then be $\frac{355.8}{1.479} = 241$ grams $= 0.53$ lb. avd. copper.

A pound of copper, therefore, calls for an expenditure of 2 kilowatt-hours.

(To be continued)

Halite is the scientific name for common rock salt.

ABBE-FRENIER SPIRAL PUMP

After considerable experiment by the Abbe Engineering Co. of New York and J. H. Frenier & Son, of Rutland, Vt., the makers of the Frenier pump, a new pump has been perfected, which is claimed to be simpler, more durable, requires less power and is better adapted to milling and concentrating mills than the Frenier or any other pump.

The stationary tank and all exposed bearings of the Frenier pump have been done away with, the tank is made round and of the same size as the spiral wheel and is fastened to one of its sides and revolving with it, as shown in illustration. The wheel and its hollow shaft sets in two bearings, the shaft next to the wheel is larger and sets and runs on two large friction wheels, which are fitted with large roller bearings, enabling the wheel to run with very little power.

On the opposite side of the wheel is a large central opening through which the liquid is conveyed to the attached re-

Abbe-Frenier Spiral Pump.

volving tank and at each revolution one-half of the spiral wheel is filled and advanced from spiral to spiral and up the delivery pipe as in the regular pump.

As all the sand and water are conveyed directly to the inside of the revolving tank the spiral wheel does not have to cut its way through thick settled sand at each revolution as in the regular pump, thus saving mucn power.

As all the sand and gritty waste are inside the wheel, no sand can possibly be spattered on the bearings and gearings as before, thus effecting a large saving in repairs and stoppage.

As the sand and water are kept in motion inside the wheel, much coarser sand or crushed materials can be elevated, and, as the scoop of the wheel does not have to cut its way at each revolution through thick and heavy settled materials and as most of the weight of the wheel is on large anti-friction wheels, very little power is required.

CONVERTING TAILINGS TO COMMERCIAL PRODUCTS

By AL. H. MARTIN.

The transformation of tailings into valuable products of commerce is of recent origin. Formerly the piles of waste rock lying around mines and dredgers was considered not only worthless, but of positive annoyance. No thought was paid to their possible use, and the material was freely given to any one desiring it. Of late years there has been a radical change and in the more favored localities companies are using the tailings to augment their earnings. The commercial use of waste rock has attracted paramount attention in California and Missouri, with other districts indicating growing interest. The tailings find their greatest use in road ballast and in the composition of concrete, with a growing demand for their employment in structural work.

The economic value of dredge and mine tailings depends principally upon their location. With adequate railroad transportation facilities and proximity to large markets, the disposal of tailings becomes a profitable business. When the mines or dredges are situated in remote sections, it naturally follows that the tailings lose commercial value, as costs of transportation render their use economically prohibitive. The dredging fields of California are admirably located for the profitable marketing of crushed rock, and it is in this state that the new industry has made greatest progress.

FIRST PLANT IN CALIFORNIA.

The first attempt to turn dredge tailings to commercial purposes in California was recorded in 1907, when the Folsom Development Co. erected a rock crushing plant at Dredge. It had a rated capacity of 1,000 tons and was designed after about two years of comprehensive experiments. The tailings were excavated by a 45-ton steam shovel and loaded into dump cars, hauled by a dinky engine to the plant. A 30 horsepower electric hoist located at the head of the incline commanding the plant raised the loaded cars to an elevation of thirty feet. From here the cars discharged onto an inclined grizzly delivering to a 42x26-inch Farrel crusher. A bin placed underneath the grizzly collected the small gravel and sand, which subsequently went to the waste piles by means of a 20-inch belt conveyor 200 feet long. A 24-inch bucket-elevator received the crushed rock from the crusher and discharged into a sizing screen 24 feet long by 48 inches diameter. The sized product passed into bins located directly beneath the screen, and over the railroad tracks. This permitted the loading of the product directly into railroad cars. The oversize was delivered to a 36x10-inch Farrel crusher and again turned to the sizing screen.

Cottage in Sacramento, Built of Natomas Cobbles and Rock.

This plant proved most effective and a good market for the crushed rock immediately developed. The management decided to increase the capacity to 1,500 tons, and to simplify operations. Accordingly the electric hoist, inclined car track and flat grizzly were discarded. A main receiving hopper, covered with timber grizzly bars, protected with steel lining ½-inch thick, was placed directly under the narrow guage tracks on which the dump cars operated. From the hopper the rock passed to a 36-inch Robins belt conveyor which discharged into a revolving screen 16 feet long by five feet in diameter. Here the gravel was separated into three sizes. Boulders over 4½ inches were received by a 42x26-inch Farrel crusher, and boulders over three inches to a 36x10-inch machine. Belt conveyors gathered the crushed rock and distributed it to the storage bins. The three-inch and smaller gravel passed to a screen 10 feet long by 42 inches diameter, where it was separated into two sizes of gravel and fine material. The larger gravels were fed to two sets of 30x20 inch corrugated rolls. A belt conveyor received the product and delivered to a 48x24-foot sizing screen located above the storage bins. The gravel was stored in six different piles. Below each pile was constructed tunnels of heavy timber. The product passed through these to an elevator which discharged into chutes commanding the railroad cars. The changes resulted in a reduction of operating costs, increases of capacity, and more rapid handling of material. Seventeen electric motors furnished power. This plant is still in commission and is now known as Natomas No. I, following its acquisition by the Natoma Consolidated of California.

$25,000,000 ROCK CRUSHING CO.

On January 1, 1909, the Natoma Consolidated of California, a $25,000,000 corporation, acquired the properties of the Folsom Development Co., the Natoma Development Co. and El Dorado Gold Dredging Co. The new interests at once recognized the possibilities of converting the waste rock into valuable products, and work on No. 2 plant was commenced. This was designed and erected by the Western Engineering & Construction Co., and particularly fashioned to meet the demands attendant upon the reduction of boulders. The plant went into commission July, 1909, and so favorable were the results that another plant was soon installed. No. 2 is located at Fair Oaks, about fifteen miles from the city of Sacramento.

The rock is excavated by a 40-ton oil-

turning Bucyrus steam shovel, and loaded into Koppel cars. Each car has a capacity of four cubic yards and operates on a narrow-guage portable track, provided with a loop permitting loaded and empty cars to pass freely. The steam shovel is mounted on a broad-guage portable track paralleling the rock pile. The cars are operated by means of a 10x14-inch dinky oil-burning engine. The cars automatically discharge into the receiving hopper, located directly beneath the track.

The hopper is composed of 4x12-inch plank lined with ⅜-inch steel plates. The mouth is 20 feet square and equippped with 6x8-inch timber grizzly bars, placed eight inches apart and guarded by steel wearing bars. A swinging gate, controlled by a chain, small drum and hand wheel, regulates the flow of the gravel in its passage from the hopper to a 36-inch Robins elevator operating at a speed of 125 feet per minute. From the elevator the rock passes to No. 1 screen which divides into 8, 4½, 3, 2½-inch and less sizes. The 2½-inch and smaller size is received by No. 2 screen which separates the ⅜-inch gravel and finer material from the larger pieces and discharges into two Allis-Chalmers 40x20-inch corrugated rolls. The small product from the screen passes to No. 3 screen which separates the sand from the ⅜-inch pebbles. The latter goes to the storage pile, and the sand to the waste dump. The gravel from the rolls is delivered to No. 4 screen which classifies into ¾ and 1½-inch sizes. The oversize goes to a 40x15-inch Allis-Chalmers smooth roll which reduces to ⅜-inch. The 3 and 4½-inch gravel from No. 1 screen is delivered to two 36x10-inch Bacon crushers, and the 8-inch to a 42-inch crusher. The combined product passes to screens No. 5 and 6, which divide the ⅜ and ¾-inch sizes from the larger gravel. The latter is next reduced in a 36x10-inch Bacon crusher and returned to No. 5 screen for redistribution. Recrushing continues until all the material has attained the desired size. Screen No. 1 has dimensions of 6x22 feet, 2, 3, and 4 are 4x12 feet, and 5 and 65x24 feet in size. Thirty Robins conveyors serve the plant.

HANDLING CRUSHING PLANT PRODUCT.

The rock from the crushing plant is divided into seven piles, graded to the different sizes of crushed material. Each pile is 100 feet long, 40 feet wide and 40 feet high, with the center pierced by a reinforced concrete tunnel 110 feet long, 6 feet wide by 6 feet high. Each tunnel is provided with a 24-inch Robins elevator belt traveling at a speed of 250 feet per minute. The conveyor extends over the railroad tracks for 25 feet and discharges into a swinging chute, which directs the rock alternately into cars on two tracks. Four swinging gates are placed in each tunnel, facilitating their operation singly or combined. The gates are placed 20 feet apart and are connected with levers and rods to a hand-wheel at the tunnel mouth. An incline chute, connected with an auxiliary chute, extends from the heads of conveyors and permits the loading of cars on a third track, and either first or second car tracks may be loaded by this chute. This permits the loading of cars direct from the crushers, if so desired, instead of from the storage piles. The plant is so arranged that should a part become disabled the remaining units may continue as though nothing had happened.

The motor house is 24 feet wide by 60 feet long, with the 24 square foot pilot house located on the roof of the power house. All motors in the main plant are operated from the pilot house and the elevation gives the operator a clear view of the plant at all times. There are four 50-horse power motors; five of 100 horse power, two of 150 horse-power and one of 75 horse-power. Switchboard and controllers were especially designed to meet the requirements of the plant. A separate and different colored light is placed directly over each controlling switch, with duplicate lights and auxiliary switch close to each motor. Signals prevail whereby any disarrangement in any portion of the plant is immediately indicated to the operator. The wires from the pilot house to the motors pass through underground conduits, eliminating danger to employes. Electricity is delivered to the plant at 60,000 volts and transformed down to 2,300 volts for delivery to motors. Transformers are inclosed in a concrete tank placed underground, with drains provided to carry off all excess oil from the tank. Every precaution has been taken to lessen fire and electrical dangers.

The steam shovel loads seven cars in eight minutes, and the dinkey-engine hauls loaded cars to the hopper and returns empty cars to the shovel in seven minutes. Ten minutes is required to load a 40-ton railroad car from the storage piles. The steam shovel and engine are supplied with oil from two steel tanks 10 feet deep nad 11½ feet diameter. Oil is passed from railroad tank cars into the tanks by a pump located near the track. Water is received from tanks having the same dimensions as the ones carrying oil. Besides supplying the engine and shovel the water tanks contain sufficient water for the fire-fighting aparatus.

Church in Sacramento. Natomas Cobbles Used in Construction.

NOW IMPORTANT INDUSTRY.

The advent of the Natomas Consolidated into the rock crushing business elevated the industry from an uncertain by-product into the dignity of a co-product, the company deriving a large revenue from the hitherto neglected waste tailings. Other interests have emulated the example with satisfactory results.

The gravel is largely used in road building, and many of the finest thorough-

fares in the north and central districts of California are paved with Natomas crushed rock. The finer material is in demand by manufacturers of concrete, while the cobbles and portions of the crushed gravel are largely employed in structural work. Some of the most pretentious business buildings and residences in Sacramento and nearby cities are largely constructed of the Natomas product. Besides supplying a demand for crushed rock that is steadily growing, the companies have been able to reclaim broad acres of land by the removal of the unsightly rock piles. The chief opposition to dredging in California has been due to charges that the industry ruined vast tracts of fertile farm and orchard lands by the storage of piles of rock on what was once productive ground. Consequently the operation of the rock-crushing companies is eliminating the objections of opponents of the dredging industry.

Crushed gravel from the mines in the Joplin, Missouri, district, is steadily growing in favor for road and structural work. The five railroads traversing the district use the product for ballast to a distance of 150 to 300 miles from the district. The product is also largely used in the building of concrete bridges, depots and viaducts by the railways. Cities in Missouri and Oklahoma are using the material largely, but the high transportation rate has restricted the employment of Joplin gravel in many instances, the railway companies apparently desiring to monopolize its use for their own work.

The mining companies of late have manifested a tendency to produce gravel that may be used wtihout further treatment. By the employment of sludge mills the objectionable sands are separated from the crushed rock and sent to distant piles, thus permitting the loading of the mill tailings directly into the railroad cars by means of incline flumes. In excavating the rock from waste piles steam shovels or cup-elevators are generally employed. The sale of gravel has yielded excellent revenues to many Joplin operators, and this branch of he mine industry has become almost a co-product. While the screening and crushing of rock has not been conducted at Joplin on the scale prevailing in California, results have been of a most satisfactory nature.

Northern Electric Depot, Nicoleus, Calif., Built Largely of Natomas Cobbles and Crushed Rock.

KINDS OF STONE MOST SOUGHT.

In the California dredging fields the rock consists largely of basalt, and the crushed material is adapted to practically any use. Flint, limestone and spar compose the Joplin tailings. The flint makes the best and longest-wearing road material, provided it is not oiled. Clean white or blue flint gravel is preferred in manufacturing concrete. Limestone is used to a considerable extent, but the spar is avoided because of its weathering tendencies. Pyritic tailings are undesirable for concrete work, owing to oxidations of pyrite and discoloring character of the resultant iron oxide. Practically any crushed mine or dredger rock will make good roads, but in structural work care must be taken to select material that will withstand the effects of the elements and maintain color.

In many of the small mining towns of California the streets are paved with rock from the waste dumps of the mines. The companies generally present the towns with all the gravel desired, and in some cases municipal rock-crushers are maintained to crush the rock to desired fineness. When transportation and carrying charges are favorable, much of this rock could be sent to more distant points and command profitable markets. The question is one that commands more attention from mine owners than has been accorded in the past.

DETECTING CARBON MONOXIDE

By GEORGE A. BURRELL.

In connection with its investigation of the causes of mine fires and explosions the Bureau of Mines is making a careful study of the methods that can be used with greatest efficiency for exploring mines containing smoke or suffocating or poisonous gases.

The presence of that poisonous gas, carbon monoxide (white damp), in the afterdamp of explosions and fires in mines has caused the death of a great many miners. An inspection of the reports of those explosions and mine fires in which men have been killed shows that this gas is often the cause of the majority of the fatalities. Haldane* makes the statement that carbon-monoxide poisoning is responsible for nearly all the fatalities. After a recent disaster at a mine in Pennsylvania in which twenty-one men were killed the bodies of seventeen men showed no such marks of violence as would be produced by the concussion of an explosion. Tests of blood from some of these bodies clearly showed the bright pink hue caused by carbon monoxide. Not only have men present in mines at the time of disasters succumbed to this gas, but rescuers endeavoring to save their unfortunate comrades have perished also.

Of the gases produced in mines, carbon monoxide is the most feared and the most difficult to detect. A miner's lamp gives warning of almost every dangerous condition of the atmosphere in a mine except the presence of this gas. Percentages of methane below these that form explosive mixtures can be detected by the appearance of the "cap" of the lamp flame, and a deficiency of oxygen is shown by the smothering of the flame in time for a retreat to be made before bodily harm can result. Carbon

* Foster, C. LeN., and Haldane, J. S. The investigation of mine air. 1905. p. 244.

monoxide, however, may be present in deadly quantities in an atmosphere without the safety lamp detecting it, because a proportion much below that required to give a cap on a lamp flame is extremely poisonous.

Other gases occasionally found in mines in harmful quantity, such as hydrogen sulphide, and oxide of nitrogen fumes can be detected even in great dilution by their odor, so that fatalities from the presence of these gases in mines are few.

The author tested the value of a wick flame as a detector of carbon monoxide in comparison with its value as a detector of methane. A Wolfe safety lamp, constructed so that prepared mixtures of air and carbon monoxide could be fed into it at the base, was used. The minimum percentage of carbon monoxide (about 2 per cent) required to produce a visible cap was found to be almost identical with the required proportion of methane. Two observers could detect no difference in the color or the height of the caps produced by this percentage of either gas. Neither could they when 3 per cent of either gas was used.

In a mine some observers, especially after becoming accustomed to the darkness ("getting eyesight," as it is termed), may detect a cap when the air contains less than 2 per cent of methane, and it is possible to detect less than 2 per cent of methane by the use of special testing lamps. But the point brought out by the author's experiments is that low percentages of either methane or carbon monoxide scarcely give caps that distinguish one gas from the other. Moreover, it has been the author's experience that when a given percentage of carbon monoxide is present in the air of a coal mine, a larger percentage of methane is usually present, so that this gas would interfere with the detection of carbon monoxide by a lamp even if carbon monoxide enough to give by itself a characteristic cap were present. It is also true that in the afterdamp of mines carbon monoxide in quantity sufficient to produce a cap usually accompanies a deficiency of oxygen and an excess of nitrogen, so that the lamp is extinguished before it can show a cap. One result of this last fact, however, is that the indications of a lamp may sometimes prevent a man from going into an atmosphere containing carbon monoxide enough to be rapidly poisonous.

The gases that come out of the crevices in the coal bed immediately after shots of explosives may contain much monoxide and hydrogen, besides methane, and when a lamp is held close to the crevices the carbon monoxide and hydrogen may cause the cap of the lamp flame to differ somewhat from the cap produced by methane alone. In exploring mines, however, the great danger to a rescue party is from small proportions of carbon monoxide—proportions so small that they have no visible effect upon the flame.

The author is aware that some mining men are of the opinion that a percentage of carbon monoxide below that which is immediately dangerous perceptibly brightens or lengthens the flame of a lamp, but he knows of no characteristic of carbon monoxide that would warrant such an opinion. A possible explanation of the brightening or lengthening, suggested by J. W. Paul, mining engineer of this bureau, lies in the fact that a party exploring a mine containing afterdamp sometimes enters a place in which the proportion of oxygen in the air is larger than it was in the place previously explored, and as a consequence the wick flame burns for a while with increased intensity. As the oxygen content of an atmosphere decreases, the flame of an oil lamp burns more dimly until, at 17 or 17.5 per cent of oxygen, the flame is extinguished.

CARBON MONOXIDE OCCURENCE.

Carbon monoxide has not been positively identified in the samples of what may be termed normal mine air collected by this bureau, except in samples collected at the working faces where the air was vitiated by powder smoke. Samples of mine air from the ventilating current, from the main returns, and from splits have been examined, also samples from inclosed areas in which the air had been still; but although the apparatus used was accurate to 0.02 per cent, the author can not state positively that carbon monoxide was present in any of the samples. A series of tests is now being conducted in which air from sealed bottles containing coal that was freshly mined at the time of bottling is being examined for minute quantities of combustible gases other than methane. Although about 12 examinations have been made on samples taken one week apart, the presence of carbon monoxide has not been positively determined.

It appears that carbon monoxide is produced in mines in harmful quantity only through the agency of heat or by the incomplete combustion of carbon that attends explosions, mine fires, the use of explosives, etc. The gas is produced by the imperfect combustion and dry distillation of coal dust in explosions, by the imperfect combustion of methane, by the burning of wood and coal with insufficient supply of oxygen, and by the contact of previously formed carbon dioxide with red-hot carbon, as when the flame of a blast or a gas explosion is projected into an atmosphere filled with the fine coal dust. The last-named cause operates toward the formation of carbon monoxide when those explosives that contain within themselves sufficient oxygen for the complete oxidization of their carbonaceous components are used in breaking down coal.

The carbon monoxide formed, with hydrogen and methane, collects in the open spaces and crevices behind a standing shot, and the miner is often burned by the flame that bursts forth when he carelessly puts his lamp close to a crevice or into an open space to examine the effect of a blast. Besides the danger that attends the burning of these crevice gases, trouble is often experienced from the gases that result from the use of improperly handled explosives in ill-ventilated parts of a mine. A series of experiments is being carried on by the Bureau of Mines to determine the gases that are produced by the firing of different explosives and the extent to which the use of the explosives vitiates the air of the working places.

PROPERTIES OF CARBON MONOXIDE

Carbon monoxide is a colorless and inodorous gas with a specific gravity of 0.967. A liter of it weighs 1.2506 grams at 0° C., and 760 mm. pressure.* It will not support combustion, but burns with a pale blue flame. The lambent flame above a grate in which anthracite or coke is burning is due to the combustion of this gas. Carbon monoxide is the main combustible ingredient of water gas, of producer gas, and of blast furnace gas, which contain approximately 15 to 40 per cent of it, and is present, but in smaller proportion, in illuminating gas made by the destructive distillation of coal. It has not been identified as a constituent of the samples of natural gas examined by the Bureau of Mines, a fact that accounts for natural gas being less poisonous than water gas, producer gas, or ordinary illuminating gas. Carbon monoxide in mixtures with air has a wide range of explosibility, from 16.5 per cent gas, lower limit, to 74.95 per cent gas, higher limit.** Methane has explosive limits that lie between about 6.1 per cent gas, lower limit, and 12.8 per cent gas, higher limit.† The lower limits cited above have reference to complete combustion and to the ignition of the gas by an electric spark. Other modes of ignition, changes in temperature, the shape of the containing vessel, differences in pressure, and the presence of more or less water vapor may change the range of explosibility somewhat. The addition of

* Rayleigh. Proc. Royal Soc. London. Vol. 62, 1897, p. 204.

** Jour. Soc. Chem. Ind. Vol. 21, 1902, p. 395.

† Idem.

a large quantity of carbon monoxide to explosive mixtures of methane and air would have the tendency to widen the upper limit of éxplosibility over that of methane alone.

PHYSIOLOGICAL EFFECT OF CARBON MONOXIDE.

The oxygen absorbed from the air in the lungs is normally taken up by the blood in the form of a loose chemical combination with the red coloring matter (haemoglobin) of the corpuscles, and in this form it is carried to the tissues where it is used. Haemoglobin not only combines with oxygen but also forms a far more stable compound with carbon monoxide and when saturated with the latter it can not take up oxygen. Hence, when the corpuscles in the blood of a living animal are saturated with carbon monoxide they can not carry oxygen from the lungs to the tissues, and death must result. According to Haldane,‡ carbon monoxide has no other effect than that resulting from its interference with the oxygen supply of the tissues, and apart from its property of combining with haemoglobin it is physiologically indifferent, like nitrogen.

The affinity of carbon monoxide for haemoglobin is about 250* times as great as the affinity of the latter for oxygen. However, if oxygen is administered to a person not too far overcome it will completely replace the carbon monoxide in the haemoglobin. In this respect pure oxygen acts about five times as rapidly as normal air, which contains approximately 21 per cent of oxygen. From air containing very small percentages of carbon monoxide, less than 0.1 per cent, the blood of a man does not take up enough of the gas to cause distress unless the man breathes air a long time. If the air contains larger proportions, the blood sooner reaches that stage of partial saturation with carbon monoxide that produces helplessness. Haldane** makes the following observation:

> The blood of a man will take up about two pints of CO or oxygen. A man at rest breathes about 10 or 12 pints of air per minute, and experiment shows that of the carbon monoxide inhaled about 60 per cent is absorbed by the blood. If a man would breathe air containing 0.1 per cent of carbon monoxide he would absorb 0.007 pint per minute. It would then take him nearly 2.25 hours to absorb a whole pint or produce one-half saturation of the blood, at which stage the limbs would become so weak as to cause them to give way when effort was made to walk. A man who is walking, however, breathes about three times as much air as a man who is at rest, hence he might absorb a pint within an hour. With 0.2 per cent of carbon monoxide the time would be one-half as long, with 0.3 per cent, one-third as long, etc.

If a man who has breathed mine air containing carbon monoxide and has retired to fresh air to recuperate, again enters workings containing this gas before the carbon monoxide has entirely been displaced from his blood, he feels the effects of the gas in less time than when he entered the workings before.

The experience of those who have been partly poisond by carbon monoxide seems to teach that usually much pain or distress does not precede collapse. One of the first symptoms is weakness of the limbs and dimnes of eyeight. For some time after resuscitation, however, there may be severe headache, or even epileptic seizures and other serious ailments.

Poisoning by carbon monoxide can take place very suddenly. For instance, a man in a mine may quickly pass from a place containing such a small quantity of the gas that he has experienced no distress into a place containing a larger quantity where, because of the already partially saturated condition of the blood, he will quickly succumb. Also, the action of the poison may be accelerated by increased exertion, such as climbing a steep incline or ladder, or lifting heavy weights.

CHEMICAL TESTS FOR CARBON MONOXIDE.

The author has by the aid of a portable gas-analysis apparatus made tests of the air in mines after explosions and fires and has thus ascertained on the spot the composition of the atmosphere in the workings. Because of the time required to make such tests and the need of the services of a person with some knowledge of gas-analysis apparatus, chemical tests of the atmosphere in a mine immediately after a disaster are not made as often as they should be. Another reason for omitting them is that quick chemical tests for small quantities of carbon monoxide are not made as successfully as are chemical tests for methane, carbon dioxide, and oxygen.

Perhaps the best chemical test for carbon monoxide, in that other gases do not interfere and very simple apparatus is required, is by the use of blood diluted with water to a buff-yellow tint. This test, in the author's experience, is capable of distinctly showing as little as 0.03 per cent of carbon monoxide in the atmosphere. The method of procedure is as follows:

One or two drops of blood drawn from the finger are diluted with water until equal portions of the solution placed in 100 c. c. test tubes have a buff-yellow color. One of the tubes is taken into the mine, and at the place where the air is to be tested about 50 c. c. of the blood solution is poured out, the mine air taking its place. The tube is then corked, taken to the surface, and gently shaken for 10 minutes. If the air contained carbon monoxide the pink color caused by the presence of carbon monoxide haemoglobin is detected by comparing the solution with the normal blood solution in the other tube.

A fresh active solution of cuprous chloride may be used instead of blood for examining air for carbon monoxide. According to the author's experience, the use of such a solution, if the apparatus is precise and is properly manipulated, will show proportions of carbon monoxide harmful to a rescue party.

THE USE OF MICE AND BIRDS.

Experiments With Mice.—In the author's opinion the use of birds and mice is superior to chemical tests for carbon monoxide in that the test is quickly made, requires no technical experience, and is sufficiently exact.

Two or three mice or small birds can be placed in a cage and carried into the mine with an exploring party. Because the rate at which chemical changes occur in them is enormously greater than it is in a man, they show symptoms of poisoning far sooner. Haldane states that a mouse weighing one-half an ounce consumes about 15 times as much oxygen as one-half ounce of the human body would consume in the same time. With 0.1 per cent of carbon monoxide in the air, Haldane found that about two hours elapsed before giddiness, etc., began to appear in a man at rest, and, according to an anlysis of the blood, exposure for another half hour would have sufficed to produce practical disablement. A mouse became giddy in ten minutes. With 0.6 per cent of carbon monoxide in the air, all of the animals tried became helpless in two minutes and rapidly became comatose or died, whereas a person breathing the mixture was entirely unaffected even after ten minutes. An examination of this person's blood showed that it was one-fourth saturated.

In experiments at the laboratory of the Pittsburgh station of the Bureau of Mines white mice were placed in air containing the following percentages of carbon monoxide: 0.16 per cent, 0.2 per cent, 0.33 per cent, 0.46 per cent, 0.37 per cent, and 0.77 per cent. The mice were placed under a tight glass bell jar having a capacity of 10 liters, into which carbon monoxide had previously been introduced. The atmosphere inside the jar was thoroughly mixed and sampled twice during the experiment, the samples being taken from different points in order to make sure that the content of carbon monoxide was uniformly distributed. The samples were analyzed by combustion of the carbon monoxide in an apparatus with which duplicate analyses agreeing within 0.01 per cent could be performed.

‡ Jour. Physiology. Vol. 18, 1895, pp. 200, 430, 463.

* Haldane, J. S., Causes of death in colliery explosions and underground fires.

** Idem, p. 17.

An analysis of the air in the jar at the end of one hour showed that the oxygen content had been depleted 1 per cent, due to the breathing of the mouse, or not enough to affect the air. In air containing 0.16 per cent of carbon monoxide, a mouse showed signs of sluggishness in about six minutes, judged by outward manifestations, did not increase to any great extent up to the time the mouse was taken from the jar two hours later. The animal's rate of breathing had dropped from a normal of 160 respirations to about 120 respirations per minute. The mouse did not evince such signs of distress as would serve, if the mouse were carried into an atmosphere containing carbon monoxide, to indicate in one hour's time the presence of 0.1 per cent of the gas.

In air containing 0.2 per cent of carbon monoxide a mouse suffered partial collapse in 15 minutes and showed decided symptoms of distress in eight minutes. At the end of an hour it had not lost all muscular power. It died in two hours.

In air containing 0.31 per cent of carbon monoxide a mouse suffered partial collapse in seven and one-half minutes and showed decided symptoms in about four minutes; but 35 minutes had elapsed before it lost all muscular power and ability to turn over when placed on its back. After removal from the bell jar, the mouse was seemingly in normal condition again in about two hours.

In air containing 0.46 per cent of carbon monoxide a mouse gave decided signs of distress in two minutes; staggered around and showed partial collapse in four minutes; and in six minutes had lost all muscular power.

In air containing 0.57 per cent of carbon monoxide a mouse showed decided symptoms of distress in one minute, partly collapsed in two minutes, lost all muscular power in seven minutes, and died in 16 minutes.

In air containing 0.77 per cent of carbon monoxide a mouse showed distinct signs of distress in one minute. It lost all muscular power in five and one-half minutes and died in 12½ minutes.

The experiments showed that in air containing the smaller percentages of carbon monoxide the mice displayed varying degrees of activity up to the time they exhibited pronounced distress. Of course, the value of the tests in exploring mines depends upon the warning that the mice give while they are being affected by the carbon monoxide, and it is especially desirable that their actions should indicate the presence of extremely small proportions of carbon monoxide, so that men will have ample time to retire from an atmosphere that contains such proportions of the gas.

In the experiments it was found that in small quantities of gas and under like conditions, one mouse might clearly exhibit signs of distress whereas another might become comatose without showing distress so distinctly. Consequently, in using the test, the mouse should be closely watched, and a man not wearing breathing apparatus should retire at once from any part of a mine where the atmosphere distresses a mouse. It is advisable to carry at least three mice at a time into a mine, and to prod them slightly if they remain too quiet, in order to observe them in action.

A man when he exerts himself by carrying heavy objects, climbing ladders, or running consumes in a given time more oxygen and also more carbon monoxide than when he rests. Consequently, a man at work might feel symptoms of carbon-monoxide poisoning that would not be clearly shown by a mouse confined in a cage in the same atmosphere. In an atmosphere containing the small quantities of carbon monoxide usually found in mines after explosions and mine fires, a person may be able to go a long distance without experiencing much inconvenience. On the return trip, however, the symptoms may become so aggravated that considerable difficulty may be experienced in getting to the base of operations or to the surface.

Experiments with Birds.—Because mice may be slow in responding to the presence, in the mine air, of such small percentages of carbon monoxide as would cause distress to a man at work, experiments similar to those performed with mice were tried with birds. Canaries were confined in a bell jar in atmospheres containing the following percentages of carbon monoxide: 0.09 per cent, 0.12 percent, 0.15 per cent, 0.2 per cent, and 0.29 per cent.

After an exposure of one hour to an atmosphere containing 0.09 per cent of carbon monoxide, a bird was not affected to such an extent that it would, if carried into a mine, indicate by its actions the presence of that proportion of carbon monoxide. Only by close observation could one detect that the bird at the end of an hour felt slightly distressed.

With 0.12 per cent of carbon monoxide in the atmosphere of the bell jar, a bird did not show clearly symptoms of being affected. In about 15 minutes it had lost its liveliness and thenceforth remained comparatively quiet. The bird did not fall from the perch, but close observation showed that it was decidedly weaker at the end of the hour than was the bird placed in air containing 0.09 per cent of carbon monoxide.

In air containing 0.15 per cent of carbon monoxide, a bird evinced symptoms of slight distress in three minutes. It gasped, gradually became weaker, swayed, and at the end of 18 minutes fluttered from the perch. At the end of an hour it had not lost all muscular power, but showed symptoms of extreme weakness.

In air containing 0.2 per cent of carbon monoxide, a bird showed pronounced signs of distress in one and one-half minutes; itbecame very unsteady in three minutes, and fell from the perch in five minutes. After it was taken from the jar, it regained its feet in two minutes and appeared to be in normal condition in five minutes.

In the air containing 0.29 per cent of carbon monoxide, a bird fell from the perch in two and one-half minutes. When placed in fresh air again, it had almost revived in five minutes.

SUMMARY.

The following table shows the relative susceptibilities of mice and canaries to carbon monoxide poisoning:

Per cent CO.	Mice—Effect.
0.16	Very slight distress at end of hour.
.2	Distress in 8 minutes; partial collapse in 15 minutes.
.31	Distress in 4 minutes; collapse in 7½ minutes; lost muscular power in 53 minutes.
.46	Distress in 2 minutes; collapse in 4 minutes.
.57	Distress in 1 minute; collapse in 2 minutes; muscular power lost in 7 minutes; death in 16 minutes.
.77	Distress in 1 minute; muscular power lost in 6½ minutes; death in 12½ minutes.

Per cent CO.	Canaries—Effect.
0.09	Very slight distress at end of hour.
.12	Weaker at end of hour than after exposure to 0.9 per cent
.15	Distress in 3 minutes; fell from perch in 18 minutes.
.20	Distress in 1½ minutes; fell from perch in 5 minutes.
.29	Fell from perch in 2½ minutes.

These tests show that canaries may be better than mice as indicators of the presence of noxious gases in the atmosphere of mines, since they more quickly show signs of distress in the presence of small quantities of carbon monoxide. In addition the symptoms of poisoning in birds are much more clearly defined. A bird sways noticeably on its perch before falling and its fall is a better indication of danger than is the squatting, extended posture that some mice assume without much struggling, attempts to walk, or other preliminary symptoms of poisoning. Consequently birds not only give more timely warning of the presence of small quantities of carbon monoxide, but exhibit symptoms that are more easily noticed by exploring parties.

RELATIVE SUSCEPTIBILITY OF MEN AND BIRDS.

In order to determine for himself the relative susceptibility of men and birds the action of carbon monoxide, the author performed the following experiment:

A gas-tight chamber, having a capacity of 80 cubic feet, was constructed. Into this chamber sufficient carbon monoxide was introduced to produce an atmosphere containing 0.25 per cent of the latter. The author entered this atmosphere, taking with him canary birds and pigeons. The canary birds evinced distress in one minute and fell from their perches in three minutes. The pigeons only showed slight signs of distress in 11 minutes. The author remained in the atmosphere for 20 minutes, and at the end of that time only suffered a slight headache, although later he became ill. The illness lasted several hours and was accompanied by nausea and headache.

The experiment shows that small birds are much more susceptible to the action of carbon monoxide than are men, and demonstrates the desirability of using small birds, such as canaries, rather than larger ones, such as pigeons.

In company with other persons the author has also witnessed practical demonstrations of the usefulness of canary birds in exploring mines after explosions had occurred therein. The following analysis shows the composition of the air about 200 feet beyond the point at which a canary bird collapsed. The bird was carried by an exploring party without breathing apparatus. A miner's lamp would burn in this atmosphere, which is typical of those that have caused many deaths in rescue parties, and would give no warning of the presence of the deadly white damp.

Composition of a mine atmosphere renedred dangerous by white damp:

Analysis of Atmosphere.

CO_2	1.49
O_2	18.25
CO	.60
CH_4	1.25
H_2	.29
N_2	78.12
	100.00

Analysis Differently Stated.

Air	Oxygen	18.25
	Nitrogen	69.07
	Carbon dioxide	.03
Black damp	Nitrogen	9.05
	Carbon dioxide	1.46
Methane		1.25
White damp		.60
Hydrogen		.29
		100.00

A sample of the atmosphere was not obtained at the exact place where the bird collapsed, but was taken at the face of a heading 200 feet beyond and close to what was supposed to have been the seat of the explosion. The exploring party was cautiously advancing along the heading when the bird collapsed; the members of the party immediately retreated without themselves feeling any distress. The bird quickly revived when placed in better air. About one hour later a helmeted party advanced to the face of the heading and collected the sample of air mentioned. The sample was obtained 18 hours after the explosion and before ventilation had been restored in this part of the heading. The carbon monoxide content of the air at the place where the bird collapsed is problematical, but certainly was less than 0.60 per cent, because the air was purer at places in the heading farther back from the face. As a rough guess, the carbon monoxide content may be placed at 0.20 or 0.30 per cent.

The following analysis shows the composition of the atmosphere in an entry that had been more or less traversed by exploring parties for several hours prior to the taking of the sample:

CO_2	0.31
O_2	20.51
CO	.04
CH_4	.20
H_2	.00
N_2	78.94
	100.00

One member complained of not feeling well at the time the sample was collected, but in prior exploration work he had probably breathed for several hours air containing small portions of carbon monoxide. Hence, his symptoms were to be attributed to the cumulative effect of the air previously breathed rather than to the immediate action of the small proportion of carbon monoxide shown in the sample.

Another advantage of the use of birds in exploring mines remains to be considered. A mine atmosphere may be so deficient in oxygen as to extinguish a lamp flame and yet may not contain so little oxygen, or so much carbon monoxide, as to cause distress to birds. In exploring a mine after an explosion a party including members of the Bureau of Mines encountered an atmosphere that, as shown by analysis of a sample, contained the following gases:

CO_2	4.10
O_2	13.64
CO	.00
H_2	.00
CH_4	1.20
N_2	81.06
	100.00

The party was not equipped with breathing apparatus but carried safety lamps and birds. When it entered this atmosphere the lamps were extinguished (an oil lamp goes out in air containing less than 17 per cent oxygen), but neither the men nor the birds showed signs of distress.

In regard to the oxygen deficiency required to cause distress in men, Haldane says:

> When the oxygen percentage of air is gradually reduced by absorption of the oxygen, or (what is exactly the same thing) by addition of nitrogen, very little may be felt before the occurrence of impairment of the senses and loss of power over the limbs. If reduction is gradual, and the symptoms be carefully watched, it will be noticed that at about 12 per cent of oxygen, i. e., with a reduction of 9 per cent, the respirations become just perceptibly deeper. At 10 per cent the respirations are distinctly deeper and more frequent, and the lips become slightly bluish. At 8 per cent the face begins to assume a leaden color, though the distress is still not great. With 5 or 6 per cent there is marked panting, and this is accompanied by clouding of the senses and loss of power over the limbs, which would probably end sooner or later in death. It is probable that any sudden exertion made in air markedly deficient in oxygen may lead to temporary loss of consciousness, so that sudden efforts should be avoided in all cases where, through accident or necessity, a man is in an atmosphere which will not support light, and in such a position that he might fall into worse air or otherwise injure himself. When air containing less than 1 or 2 per cent of oxygen is breathed, loss of consciousness, without any distinct warning symptoms, occurs within 40 or 50 seconds. Loss of consciousness in air deprived of oxygen is more rapid than in drowning or strangling, since in the former case not only is the supply of fresh oxygen cut off, but the oxygen previously in the lungs is rapidly washed out. Loss of consciousness is quickly succeeded by convulsions, which are followed by cessation of the respirations. The heart still continues to beat, in the case of cats and dogs, for from two to eight minutes; in man this period is probably longer, for it seems to be the general rule that the larger an animal is the longer it will resist asphyxiation. So long as the heart is beating, however feebly, animation may be restored by artificial respiration. This may require to be continued for a considerable period, as the after effects of deprivation of oxygen are very serious, and the respiratory center may not recover for some time.

The above statement shows why the atmosphere previously mentioned put out the lamps, but did not affect the men, and seemingly had little effect upon the birds. Of course men not wearing breathing apparatus should retreat at once from an atmosphere that extinguishes an oil-lamp and thus avoid the possibility of suddenly entering an atmosphere so deficient in oxygen that safe retreat would be difficult. For although birds would undoubtedly indicate in season a deficiency of oxygen sufficient to cause distress to men, if further advance were made, yet immediate retreat from an atmosphere in which a lamp does not burn assures a larger margin of safety.

In bringing these tests to the attention of miners and mine officials the author makes no claim to originality in the use of birds or mice for the purpose

of detecting harmful quantities of carbon monoxide in the air of a mine. Dr. Haldane strongly recommends their use. In this country, however, small animals have been used for the purpose described in comparatively few cases. For that reason and because the test is so simple and practical the author has added his observations to the work of Dr. Haldane in order to urge the general adoption of the test in this country. The fact that no series of tests of the comparative merits of birds and mice in atmospheres containing the entire range of small quantities of carbon monoxide had been made is a sufficient reason for the experiments described in the preceding pages. Further, the author's observations indicate that mice are hardly as sensitive to carbon monoxide poisoning as Dr. Haldane's experiments would indicate, and that small birds are better indicators of poisonous atmospheres than are mice.

How Copper is Sold and Speculated In

By W. R. INGALLS.†

The interest of the miner and the metallurgist extends to the production and disposal of the refined metals. In their subsequent utilization by the drawers of wire, rollers of sheet, etc., he usually has no concern. The last step of interest to him, and this is of vital interest, is consequently the sale of the refined metals. The details of the selling, the methods and conditions thereof, and in short all that pertains to the marketing are not, however, well understood. There have been, in the Journal, many articles upon this subject, but even in such a matter as selling metals there are changes in practice and therefore this present series of articles will not be wholly a repetition of what has been said previously. It is not my intention to touch upon the selling of iron and steel, or of many of the minor metals, such as antimony, nickel, etc., but rather to confine myself to copper, lead, zinc and tin, with brief references to aluminum and quicksilver. I shall begin with copper as the metal of superior interest.

I shall not enter far into the subject of statistics. It will be sufficient to remark that at present the world's production of new copper is about 2,000 million pounds per annum, whereof about 1,450 million is the product of American refineries. The predominance of America in the world's market is therefore self-evident. This predominance is emphasized if it be further stated that of the remaining output a considerable portion is consumed in the respective countries of production, e. g., this is the case of Russia, and is not competitive.

Besides the new copper there is a considerable production from scrap and junk, which to all intents and purposes is equivalent to new copper. In the United States this production amounts to about 60 million pounds per annum.* It appears therefore that the total production of copper in the United States is fully 1,500 million pounds per annum, the disposal of which implies the selling of an average of five million pounds per day of business. It is evident from these figures that transactions in the copper market must go on all the time and that in the dealings of first hands they must be of high order of magnitude. In the business from this standpoint the carload is representative merely of retail trading; one hundred thousand pounds is a relatively trifling unit; a million-pound lot is only ordinary in periods of activity; and transfers of much larger blocks are common. Transactions to the amount of 30,000,000 pounds per week only dispose of the current production, without allowance for resales. When the market is classed as dull, a weekly business to the amount of many millions of pounds is likely to be done, but less than the average. Business has to be upward of 30,000,000 pounds per week to be pronounced brisk.

KINDS OF COPPER.

Copper is marketed in four principal kinds, viz.; 1, Lake; 2, electrolytic; 3, pig; 4, casting. Lake and electrolytic are marketed in three principal forms, viz.: cakes, wirebars and ingots. Pig copper, as its name implies, is sold in pigs, while casting, generally goes in the form of ingot. Cakes are commonly rectangular slabs of the metal; rarely discs. Cakes are used chiefly by the rollers and spinners. Wirebars are long bars, of square cross-section, tapering at one end to facilitate passage through the rolls of the wire mills. Ingots are the well known pigs that are partially divided into two or three sections, which is to facilitate the breaking of them for introduction into melting pots. Ingot copper is in fact used chiefly by the makers of castings and alloys, brass being the most important of the latter. Besides the ordinary ingots there are also what are called "ingot bars," weighing 60 to 90 pounds, which are divided by three to five notches.

Cakes and wirebars as furnished by the several refiners are generally of about the same size and shape, but there are some manufacturers who require special shapes and often pay a premium for them. Sales of copper at a fancy price are occasionally reported in the newspapers and heralded as marking an advance in the market, whereas in fact they represent merely some purchase of copper in a special shape and perhaps also of a special brand.

LAKE COPPER.

As its name indicates, Lake Copper is produced by the mines of Lake Superior, and indeed it is produced only by them. Formerly it was relatively of much more importance than it is now, but during the last 20 years electrolytic has displaced it as the kind of metal of superior importance although in certain ways it still retains the premier position. Electrolytic is, however, now conceded to be superior to Lake in conductivity and equally good in some other respects. Lake copper is superior in the combination of high conductivity with high toughness, but in the main it holds the esteem that wins for it a pre-

† Editor Engineering & Mining Journal in May issues.

* Statistics of the recovery of copper from scrap and junk are conflicting and confusing unless they be carefully defined. Most manufacturers of copper have scrap and trimmings, which they remelt or return to the refineries for remelting. Manifestly such copper should be excluded from statistics because it has never been used. The correct view of the secondary recovery of copper is, in my opinion, confined to what is obtained from the reworking of old material, i. e., material that has been used, collected, and restored to the market in the form of ingot, etc., thus becoming to all intents and purposes new copper, with which it is in fact competitive. Such recovery is practiced not only by smelters who make it their special business, but also by the refiners whose chief business is the treatment of virgin copper.

mium in the market to a hoary prejudice on the part of some manufacturers who continue to demand it because they always have, because it has proved good, and because they don't want to take chances in trying anything else. Given two lots of the same metal cast in different molds, one with an old, well-known name and the other with a new one and some melters will report different results. Such absurdity is gradually disappearing with the introduction of the chemist into the brass works and other factories.

Lake copper is marketed as three distinct kinds, viz., special brands (Calumet & Hecla and Quincy); prime Lake (Tamarack, Osceola, Wolverine, etc., including the electrolytic Lake refined by the Calumet & Hecla at Buffalo) and arsenical (Copper Range, Isle Royale, etc). These brands command different prices, the specials generally realizing a little higher and the arsenical a little lower price than the good, ordinary Lake copper. However, this is not always the case. At some times the arsenical copper sells on a par with first-class casting, but there have been times when a demand for copper high in arsenic has brought for it a price superior to prime Lake copper.* Similarly there have been times, especially during periods of decline in the market, when the best grades of Lake copper have been sold on the same terms as electrolytic. In general, however, prime Lake copper commands about 0.25c. per pound more than electrolytic, basis New York, but not so much on basis of delivery. Further on I shall dwell more in detail upon this subject. Lately the Calumet & Hecla has been making a differential of ⅛c. per pound between its Torch Lake and Buffalo copper.

ELECTROLYTIC COPPER

The production of electrolytic copper now amounts to about 80 per cent of the total American production, and 70 to 75 per cent of the world's production. Because of its excellence and the magnitude of its supply it occupies the leading place in the copper business. When the price for copper is referred to without qualification the common understanding nowadays is that the price for electrolytic copper is meant.

The electrolytic copper produced by the several refineries is substantially uniform in quality. Certain brands, e. g., B. E. R. and N. L. S., have at times enjoyed a little preference and indeed have commanded a small premium, but at present no material differences are recognized and the respective agencies compete upon an equal basis. The standard specifications, approved February 18, 1910, provide that all wirebar and cake copper shall have a purity of at least 99.9 per cent, silver being counted as copper, and an electrical resistivity not greater than 0.15535 international ohm per meter-gram at 20 degrees C. The specifications of the American Society for Testing Materials adopted in 1911 are as follows:

The copper in all shapes shall have a purity of at least 99.880% as determined by electrolytic assay, silver being counted as copper. All wirebars shall have a conductivity of at least 98.5% (annealed); all ingots and ingot bars shall have a conductivity of at least 97.5% (annealed), excepting only arsenical copper, which shall have a conductivity of not less than 90% (anneled). Cakes, slabs and billets shall come under the ingot classification, except when specified for electrical use at time of purchase, in which case wirebar classification shall apply. The annealed copper standard, or resistance of a meter-gram of standard annealed copper at 20° C., shall be considered as 0.15302 international ohm. The percentage conductivity for the purpose of this specification shall be calculated by dividing the resistivity of the annealed copper standard by the resistivity of the sample at 20° Centigrade.

Wirebars, cakes, slabs and billets shall be substantially free from shrink holes, cold sets, pits, sloppy edges, concave tops and similar defects in set or casting. This clause shall not apply to ingots or ingot bars, in which case physical defects are of no consequence.

Five per cent. variation in weight or ¼ in. variation in any dimension from the refiner's published list or purchaser's specified size shall be considered good delivery; provided, however, that wirebars may vary in length 1% from the listed or specified length, and cakes 3% from the listed or specified size in any dimension greater than 8 in. The weight of ingot and ingot-bar copper shall not exceed that specified by more than 10%, but otherwise its variation is not important.

These specifications do not take into consideration the so-called casing copper used for the purpose of alloying with other metals to produce cast shapes.

BRANDS OF COPPER.

A list of the important brands of copper in the American market is as follows:

American Smelting & Refining Co.	P A
American Smelters Securities Co.	BER, BCW,† Tacoma
Anaconda Copper Mining Co.	M A
Arizona Copper Co.	A C C†
Balbach Smelting & Refining Co.	Bb† N B C
Calumet & Hecla Mining Co.	C H M Co.
Copper Range	C R
Nichols Copper Co.	N L S, R M C
Phelps, Dodge & Co.	C*Q, P D C†
Quincy Mining Co.	Q M Co.
Raritan Copper Works	N E C
Tamarack & Osceola	T M Co.
Tennessee Copper Co.	T C C†
U. S. Metals Refining Co.	D R W

† Casting.

SMELTING AND REFINING.

The smelting of Lake copper is a relatively simple process as is also the refining which is done in the same works. These works are near the mines in Michigan, except the plant of the Calumet & Hecla at Buffalo, N. Y., and from them the copper goes directly to the manufacturers. The C. & H. v
at Buffalo comprise an electrolyt
finery in which some of the more
tiferous copper is refined. The c
so refined constinues to be class
Lake copper. At the Dollar Bay
ery a proportion of Montana cat
used to be smelted with the Lak
per, the product going into the m
as "Lake."

The refiners who rework scra
junk, producing casting copper, e
reverberatory furnaces, the refinin
cess being simple.

All of the other producers of c
turn out a first product known as
blister copper, this being the
metal poured from the bessemer
verters. Nearly all of the proc
have converter plants, but a few
their products as matte to other
verters. The refiners receive a
proportion of their crude copper i
form of anodes, some of which i
strictly blister copper.

The bulk of blister copper go
the electrolytic refiners, it being
sary both to eliminate impurities a
extract its gold and silver content.
of it, however, is non-argentiferou
sufficiently pure as it comes fro
converters to be used as casting c
after a simple furnace refining.
copper is marketed as pig or bes
copper and to a large extent is exp
The product of the Arizona Copper
pany, Detroit Copper Company and
nessee Copper Company is of this
Some of it contains enough silver
near the dividing line and goes di
into consumption or to electrolytic
ing according to commercial cond
sometimes one way, sometimes
other. At present only the ACC c
is sold as pig. The product of th
troit Copper Company is market
PDC (casting) and that of the Ten
Copper Company is either market
casting or is electrolytically refin

The first marketable product c
electrolytic refiners is cathode c
i. e., the refined metal in large,
electrolytically deposited plates c
from the tanks. The cathodes g
erally to melting furnaces where
process of refining is complete
whence the copper is cast as cakes
bars, or ingots, but there are som
ers of cathodes who do the rest
process in their own works. Muc
cathode copper is sold now tha
merly. The major part of what
posed of in this form goes to E
The cathode allowance for export
riable, ranging from 5 to 10s. per
pounds (0.054 to 0.108 per pound
shipping copper in this way heavy
es in weight (0.25 to 0.75 per cen
cur, owing to the brittleness o

* The arsenical Lake copper constitutes a class by itself, having a distinct market. It cannot be used in place of prime lake, nor of electrolytic, but finds employment either as casting copper or rolling copper. For the latter purpose it is in good demand, owing to the high tensile strength of the sheet made from it.

plates and the rough handling in loading and unloading.

ELECTROLYTIC REFINERIES.

The following is a list of the electrolytic copper refineries of the United States, together with their situation and a statement of their capacity at the end of 1911:

Works.	Location.	Capacity, Pounds
Nichols	Laurel Hill, N. Y.	330,000,000
Raritan	Perth Amboy, N. J.	330,000,000
Baltimore	Canton, Md.	288,000,000
A. S. & R. Co.		180,000,000
U. S.	Chrome, N. J.	180,000,000
Balbach	Newark, N. J.	48,000,000
Anaconda	Great Falls, Mont.	65,000,000
Tacoma	Tacoma, Wash.	28,000,000
C. & H. Min. Co.	Buffalo, N. Y.	55,000,000
Total		1,494,000,000

THE SELLING AGENCIES.

A few of the producers sell directly their copper and handle no other copper. This is the practice of the Quincy, Miami, Mohawk and Wolverine companies. Other companies sell their own copper and also act as agents for other producers. Thus, the Calumet & Hecla sells the product of the other Lake companies in which it is a stockholder. The Anaconda Copper Mining Company, through the United Metals Selling Company, sells the Cananea, Copper Range and Highland Boy copper, Phelps, Dodge & Co. sells the Calumet & Arizona. The American Smelting and Refining Company sells the Utah, Nevada, Ray, Chino and Tennessee copper. These concerns sell their outside copper on commission, the rate now being commonly 1 per cent. The American Metal Company and L. Vogelstein & Co. act both as agents and as traders. The one large producer, Calumet & Hecla, and the five agencies that have been mentioned sell about 80 per cent of the total American copper product. Beer, Sodnheimer & Co., E. P. Earle, and one or two other concerns handle relatively small quantities.

These concerns constitute the "first hands." Besides them there are numerous dealers who conduct a speculative or distributive business, or a combination of both. Their supplies, barring what comes from the scrap and junk smelters, are of course obtained from the producers and agencies either by purchase or by representation. Virgin copper has been known to be delivered against sales through unusual channels.

INTERNATIONAL RELATIONS.

Approximately one-half of the production of American refineries is consumed in the United States; the other half is exported to Europe. Copper moves freely from one country to another, there being no import duties except into Russia and perhaps some minor countries. These conditions create an international market for copper, i. e., the American and European price is in general the same, allowing for freight differentials. The principal nominal markets are New York and London; the only other public market that comes into consideration is Hamburg. In importance Hamburg is decidedly inferior to London, to which in the main it conforms.

In New York the dealings are wholly in refined copper; in London they are both in refined sorts and in what is known as "standard" under a form of contract determined by the metal exchange which classifies and rates most of the commercial kinds of copper. Transactions upon the London Metal Exchange are conducted under systematized rules and the open market that is thus established is the focus of extensive speculation, which is no more confined to London itself than are the transactions on the New York stock exchange confined to Wall Street. Both of these places are simply the points of execution of orders emanating from all parts of the world. Thus, many of the speculative movements originate from orders cabled from New York and several American houses are prepared to conduct such business, in which public interest upon certain occasions has been openly invited, just as it might be invited to participate in speculation in cotton or wheat.

In view of these connections it is obvious that while the London and New York copper markets may temporarily exhibit a disparity, such a condition can not long exist, generally for not more than a few days, inasmuch as disparity immediately opens the way to profitable arbitrage business. If "standard" at London rises above the New York parity the American agencies may sell contracts and deliver their refined copper against them. On the other hand, if "standard" falls below the parity they may cause their refined copper to move at concessions and cover their sales by purchases of "standard" in London. There are frequently triangular and even quadrangular or more complicated transactions, such as occurred several years ago when China was playing an interesting part in the copper market. The details of these are often too abstruse to be understood by anyone except the traders who make it their business. The number of houses in a position to conduct arbitrage business is in fact small.

A consideration of the nature of this international business makes it manifest that the American and Europen markets must stand at the same level during most of the time. A movement may start in London or New York; if the start be in London it may be specifically inspired from New York; and a general change in level may be anticipated on one side or the other, which is why New York watches London so carefully, and vice-versa, but natural conditions prevent any disparity from being of anything but temporary character.

NEW YORK A BASING POINT.

While New York is the great market for copper and while the price for copper in New York is the commonly accepted basis, a great deal of the copper sold, perhaps the major part, never physically enters New York. The electrolytic refineries, with a few exceptions, are situated on branches of the bay of New York, four of them being in the State of New Jersey and only the Nichols works in New York. This, however, is merely a technical distinction, three of the large New Jersey refineries being separated from the municipality of New York only by a narrow body of water. At the refineries the copper is loaded on lighters by which the copper is taken to the steamship docks for export or to the railway docks for transhipment to interior domestic places. In a few cases direct delivery to manufacturers can be made by lighters and to some extent the copper is shipped directly from the refineries in railway cars. The greatest manufacture of copper is on the Naugatusk valley in Connecticut. There are important isolated centers, such as Trenton, N. J., Rome, N. Y. and Detroit, Mich. The copper that goes westward from New York has to stand a back freight through the longitude that it has already traversed in coming eastward as blister copper. Not so with the electrolytic copper coming from Tacoma and Great Falls or the Lake copper from Michigan. When copper is delivered from western manufacturing points it is a common practice of the Lake producers to settle on the basis of the New York price with freight allowance. In the case of the electrolytic producers conditions are more complicated because of the trade custom respecting delivery.

PRICE RATES.

The price for copper is quoted to buyers in a variety of ways, whereof the more important are as follows: New York, cash; delivered, 30 days time for payment; delivered, cash; delivered, cash, less 0.5 per cent discount; f. o. b. dock, New York (for export); delivered in Europe, c. i. f. (cost, insurance and freight). Formerly copper was sold on a strictly cash basis. At present the custom of granting time prevails in the domestic business, the larger part of the copper being sold on terms that include delivery at the buyer's works (the seller paying the freight), allowing 30 days (after arrival of the copper) for pay-

ment; and discounting the bill for cash. This is the meaning of the common, commercial phrase "delivered, 30 days." The custom of quoting copper in this way is now so general that the explanatory phrase is commonly omitted, which makes it necessary to employ an explanatory phrase when the basis be different. If it be said in the trade that the price of electrolytic copper is 14c. it is understood what that means, but outside of the trade such an understanding does not generally exist. The net, cash price, basis New York, is of course a very different thing from the price delivered, 30 days. In the foreign business the c. i. f. basis is also one of delivery, the seller landing the copper at some European port.

The practice of selling copper to domestic manufacturers* on the delivery and time basis was, I believe, inaugurated in the '90s. Lake copper was naturally delivered to them directly from the west and in introducing the then new kind of copper—electrolytic—coming from the west via New York it was reasonable to offer it to the manufacturer on terms that relieved him of a study of freight rates. The innovation of time allowance against the old cash basis was inspired doubtless by competitive reasons and coincided with the elimination of the middleman (broker), the rise of the great agencies possessing large financial resources, and the direct dealing with manufacturers whose credit was good and well known. Losses through bad accounts in the copper business as now conducted are almost an unknown occurrence.

The granting of time on copper bills is of course a concession to the buyer, because the latter gains and the seller loses interest on the money, although this is not figured by some producers in their accounts. They reckon a sale as a sale irrespective of when they receive their money, but the interest on the money involved in the transaction accrues to some one, nevertheless, and is recognized in the discounting of bills for cash.

The time allowance is not a commendable practice or to the best interest of the business. At certain times it has been abused. In shipping to Connecticut the refiner in New York figures upon financing the consignment for about 45 days, the time while the copper is in transit being about 15 days. The buyer may take advantage of the agreement by delaying the receipt, i, e., delaying weighing in or entry upon his books, from which he begins to count his 30 days, and the seller is impotent, being anxious to avoid giving offense, especially when competition is keen.

For the most part, Lake copper is sold directly by producer to manufacturer; however, some of it is distributed through the selling agencies and some through metal brokers. The several sellers of Lake copper do not adopt the same plan in making their quotations. Some sell on the basis of New York, net cash, adding or deducting difference in freight between shipping point and New York. Thus, in selling copper for delivery at Buffalo, some producers name their New York price and deduct the difference in freight between Michigan-New York and Michigan-Buffalo. Other producers sell at a price including delivery to the manufacturer's yard, allowing 30 days' time for payment, or not, as the case may be. Some producers selling to brokers allow them a commission of 0.5 per cent and in selling directly to manufacturers give them (the manufacturers) the same allowance, which of course is simply a trimming from the nominal price. When the bill is discounted for cash the total discount comes to 1 per cent. This allowance is not made by all of the Lake producers.

The agencies which sell the bulk of electrolytic copper differ slightly in their methods, but in the main they are obliged to accommodate themselves to each other in order to remain competitive. The transactions in electrolytic copper come under three heads, as follows: (A) Sales to manufacturers situated in the west. (B) Sales to manufacturers situated in eastern districts. (C) Sales for export.

WESTERN SALES

The manufacturers situated in the west are, as a rule, supplied by the western refiners, who have a double advantage, saving a part of the freight to the Atlantic Coast and obtaining a higher price for their product, eastern refiners being obliged to pay freight backward in order to compete. The western refiners in selling at interior points, are, however, limited by the competition of Lake copper. This will be made clear by the following example:

Assuming the price for electrolytic copper to be 12½c., net cash, New York, and the price of Lake copper to be 12¾c., same basis, if a western refiner sells at 12½c., Chicago, he saves about ⅛c. freight from Chicago to New York. In order to realize the equivalent of 12½c., cash, New York, the eastern refiners would have to quote 12.70c. at Chicago. The Lake producers can afford to sell at 12⅝c., Chicago, netting the equivalent of 12.75c., New York. Consequently, in times when there is a fair market for copper, the price in Chicago is likely to be just enough lower than the price for Lake copper to induce the buyer to take electrolytic instead of Lake and still sufficiently high to make it more profitable to the western electrolytic refiner to sell there than in New York. The result of this condition is that in ordinary times the eastern refiner does not compete in the western market. If business, however, is slack and it is difficult to sell copper, the eastern product will be offered competitively in the west, because then it is chiefly a question of finding a market and the equalization of freight becomes a secondary consideration.

DELIVERIES TO EASTERN POINTS.

Similarly copper may be delivered to some interior points more advantageously from Baltimore than from Perth Amboy. These conditions produce complications in the competitive selling of copper at points west of the Atlantic Coast and in connection with the prevailing custom of the trade affect materially the price quoted for any particular point and the amount that the seller will net. The producer of Lake copper often finds himself embarrassed by widely different freight rates, the rate from Michigan to Connecticut by rail being about 34c. and by water and rail only about 18c. This materially influences his attitude toward the market at the opening and closing of navigation and gives play to the operations of shrewd outside speculators at about those times.

In selling upon the basis of price delivered to domestic manufacturers, with time allowance, or discount for cash, the freight that is paid by the sellers differs naturally according to the respective situation of the refinery and the manufacturers' works. Thus, while the refiners at Perth Amboy have merely to pay a switching charge for delivery of copper to a Perth Amboy wire mill, a refinery situated on Long Island has to pay a lighterage charge or a freight charge. The freight from the principal refineries around New York to the principal mills varies from a switching charge of 1c. per 100 pounds to a rate of 18c. per 100 pounds. It has become the custom among the principal selling agencies to quote a uniform rate, disregarding differences in freight, the idea being to treat all consumers alike and the assumption being that in the long run the freight will equalize itself. A

* Throughout this article I refer to the "manufacturer' rather than the "consumer." The real consumer rarely enters directly into relations with the refiner. The latter sells to the manufacturer of wire, etc., who is simply a middleman one step further in advance. There are, however, some large users of wire, such as the General Electric Co. and Western Electric Co., which buy wire bars and have them drawn on toll or contract, but even they are not the ultimate consumers.

very large part of the shipment of copper goes to the Naugatuck valley in Connecticut, the freight rate to there being about 10c. per 100 pounds, which expense is generally assumed to be about the average. This rate, however, applies to only part of the shipments, a large part of the Western copper going through on milling in transit rates, which reduce the cost of delivery from New York 4½@7½c. per 100 lb. The producers who sell copper to domestic manufacturers in the east, are consequently subject to freight charges of from 4½ to 12½c. per 100 lb., or even a little more to some out-of-the-way places.

The terms, cash 30 days after arrival, are generally reckoned as corresponding to an average interest loss of 45 days, which amounts to a little more than 10½c. when figured on a price of 14c. per pound and at 6 per cent interest. Several of the large agencies sell at the flat discount of 0.5 per cent for cash upon delivery, which is 7c. per 100 pounds when the price of copper is 14c. The net cash equivalent, New York, of a sale "delivered, 30 days," is consequently from 12½ to 20c. per 100 pounds less than the commonly quoted price. What the producer realizes comes back, of course, to the basis of New York, cash. The variation in terms is frequently a method of shading prices without jolting the nominal position of the market.

SALES TO EUROPE.

Sales to Europe are made by the several agencies through their European manufacturers. A custom similar to that in the domestic trade exists with respect to quoting a uniform price for delivery at various ports regardless of difference in freight. In times when business is brisk an exception is likely to be made in quoting for delivery to the so-called "outports," to which the freight rate is materially higher than to Liverpool, London, Rotterdam and Hamburg. However, in times of keen competition some of the sellers prefer to waive the differential for the so-called "outports" rather than to reduce their price.

The average freight rate to regular ports in Europe is about 11c. per 100 pounds,* the insurance amounts to about 1.5c., interest and banking expenses 3c., and brokerage (at 0.25 per cent) 3c., making the total of charges about 18.3.** The terms of payment for European sales vary; common conditions are three days' sight draft, or sight draft on consumers, or cash on arrival of steamer. In either case the seller suffers a certain loss of interest or a loss in the rate of exchange. Some sellers extend credits to European buyers and in consideration thereof sometimes receive higher prices, the credits ranging from two weeks to three months. It is a common custom when making sales to Europe on credit to sell the risk to a bank at an expense of ¼ to ½ per cent. The average cost to the seller of delivering copper to regular ports in Europe is about 17½c. on the average, some figuring it a little higher (20c.), some a little lower (15c.)

With respect to what is actually netted by the seller it appears, therefore, that there is no material difference between the selling for delivery in America and in Europe upon the usual terms in each case, i. e., when ocean freights are normal.

CASTING COPPER.

The market for casting copper is relatively narrow and erratic. In the market for this sort the smelters of scrap and junk figure prominently, their product being casting copper and trade customs are not so firmly established as they are in the market for other kinds of copper. This is to say, casting copper may be sold in almost any way that occurs to the imagination and may be agreed upon by the parties concerned. It is sold upon the basis of cash, New York, and upon the basis of delivery, with or without time allowance. Time allowance may run to considerably more than the 30 days commonly allowed on electrolytic bills. The credit of buyers and sellers is also a more important consideration in this market than in the others.

In general casting copper is worth from 12½ to 20 points less than electrolytic, but the ordinary disparity may not always appear in the records of actual transactions. Electrolytic copper is quoted upon the basis of a wholesale market in the broadest sense, while the business in casting copper is always relatively of a more or less retail character. Thus it may actually happen that transactions in casting copper may be made at a higher price than for electrolytic, which, of course, is in no way a true index of actual market conditions, but merely the difference between a retail and a wholesale market.

Neither casting copper nor cathode copper is a reliable basis for commercial calculations, except in so far as concerns transactions in those particular forms, which in fact are of minor importance. Lake copper is a more valuable index inasmuch as its sales represent upward of 200,000,000 pounds per annum, and the record of Lake prices is important because it goes back to the early years of copper production, while the record of electrolytic is still comparatively brief. The real index of the copper market is the price for electrolytic copper and that ought always to be the basis, both casting and cathode copper being subject to erratic and non-indicative varitaions.

CONTRACTS.

The expression of "the spot price for copper" is sometimes used, but it is substantially meaningless. There is no stock of copper in warehouse at New York that is capable of delivery on demand. There may be such a stock at the refineries, but even when the refiners have an ample supply of refined copper on hand, about 10 days after receipt of order is usually expected as an allowance of time in which to conform to specifications as to shape of bars, etc. Such a filing of an order would be called "prompt delivery." The bulk of the copper is not sold in that way but rather is sold on contracts for forward delivery. Few manufacturers conduct their business upon the basis of hand-to-mouth buying, although they may approach that condition in periods of great plethora of supply, such as existed in 1910 and 1911. A manufacturer receives orders for wire, brass and other goods to be delivered at a subsequent date or during a period beginning with some date. Knowing pretty nearly what his requirement for copper is going to be, he places contracts with the agencies for delivery on their part at corresponding periods. The agencis are generally desirous of providing for the disposal of their product as far ahead as possible, but neither buyer nor seller is commonly disposed to take chances on the market for more than two or three months ahead. This practice of contracting explains the alternating periods of dullness and activity in the copper market. Having during January, let us say, arranged for their February and March

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*This refers, of course, to what may be considered normal conditions. Lately there has been a sharp rise in ocean freights, which has affected copper shipments as well as other commodities. Thus, the rate on copper from New York to Liverpool has gone from 7s. 6d. to 15s. (from 8.1 to 16.2c. per 100 lb.); the rate from New York to Hamburg has gone from 10c. to 16c. per 100 lb.; and the rates to other ports about the same way.

** The bank commission (1.5c) may be saved by drawing directly on customers, but such drafts are frequently subject to foreign stamp taxes, and moreover a draft on a commercial or industrial concern cannot be sold so well as a draft on a bank, wherefore the net result is likely to be about the same as if the drafts be sent to a bank for collection, with a commission to the bank, which is the practice of some of the selling agencies. The interest (1.5c.) is always a disputed item in these calculations. Some of the agencies figure it, some do not. Some concerns reckon the brokerage at upward of 0.25%, there being few, if any, of the sellers who are not subject to higher charges than that nominal rate. Some figure 5c. per 100-lb. with copper at about 14c. These points explain the differences of opinion respecting the charges upon European shipments that exist among the selling agencies.

copper, buyers may keep out of the market for a month or more before opening negotiations for their April requirements, especially if recession in the market is anticipated. On the other hand, if an advance is expected, they are likely to keep right on in their buying, keeping steadily booked up for two or three months ahead. Some manufacturers contract for their supplies upon the quotational basis, ordering their requirements from day to day, or from week to week, as wanted, and settling upon the basis of the monthly average. The manufacturers who do this escape the risk of speculative pinches (losing also, of course, the chances of speculative profit) but in the long run undoubtedly come out as well as the manufacturers who rely wholly upon their trading ability.

European manufacturers as a rule are compelled to cover their wants further ahead than the American because by far the larger portion of their supply must be brought over sea. A manufacturer who needs a certain shape of wire bars at his mill in Germany in March, for example, will have to buy it ordinarily in January for February shipment from the United States. The London standard market creates a complication for the selling agencies and no matter whether they like it or not, they have to graduate their quotations for forward delivery somewhat according to the premium that may be being paid for standard for forward delivery. If they should not do that their copper would ultimately find a market in London anyhow.

The custom for contracting for future requirements that prevails in the industry not infrequently leads to irregular conditions. Thus in periods of extraordinary demand, as in 1906, when stocks on hand had been substantially exhausted and refiners had become substantially sold out for one or two months ahead, a belated manufacturer requiring immediate delivery may be obliged to offer such a premium as will induce some holder to resell or to uncover some reserve supply. On the other hand, in periods when the condition of the market is the opposite a producer needing immediate cash may be unable to sell in such a way as to produce it except at a sacrifice, but may be able to sell for forward delivery and instead of waiting for his money may discount his contract. Transactions of either kind are small in relation to the great volume of business.

SPECULATION.

Speculation in the copper business in this country is severely discouraged, for the simple reason that the producers and agencies are primarily concerned with the merchandising of copper. They cannot regulate the European market in this way and are obliged to meet conditions over there as they find them, but in this country they can and do refuse to sell to any but manufacturing interests. The refusal does not necessarily take the form of an absolute declination, but may be conveyed by the quotation of a prohibitive price. All of the agencies do not, however, consistently follow this policy. Some of them at certain times have distinctly encouraged speculative participation even on the part of persons who are no more concerned in the copper industry than they are in cotton or coffee, undertaking to carry copper on margin in the refinery yards. The seller may later on be plagued by the competition of copper in his own yard. This kind of speculative business is by no means general.

It is impossible, of course, for speculation to be carried on in other ways, either regularly or only occasionally. Thus the representative of an European buyer who has purchased for export may turn around and resell in this country. Similarly a manufacturer who has contracted for copper not yet shipped from the refinery may offer it for sale on his own account.

In spite of the discouragement of speculators pure and simple and also of brokers, a few manage to do business under handicaps. Some of the Lake producers do not hesitate to sell to brokers and at certain times it is fancied that electrolytic copper may be put in their hands by some of the great agencies, which, while ostensibly out of the market, asking a price that they are unable to get, are not averse to cutting prices vicariously.

A consideration of all the conditions that have been discussed in the foregoing sections of this article will explain why business in copper on the metal exchange of New York practically disappeared and why it has been impossible to revive it. The producers and agencies, now few in number, are able and not "on 'change." The few trans- to merchandise their copper without the intermediary assistance of brokers and middlemen. The customs that have developed in the trade, moreover, do not conform to the customs of trading on in exchange. The American market for copper is in the offices of the agencies and not "on 'change." The few transactions that take place on the latter are insignificant and command no general attention.

MARKET INFORMATION.

The question may be asked, how do dealers in an unorganized market, a market in which there is no public exchange, truly speaking, obtain the information that is necessary for th duct of sharp competition. In fac is done in the same way as in the ket for pig iron and many othe stances. In this present era of t ephone, physical meeting between ers and sellers is unnecessary. ies are made and transactions inv large sums of money are consum over the telephone.

The agencies manage to keep posted through their elaborate org tions and continual intercourse buyers. Offerings in Europe promptly cabled back to New York mestic buyers generally do some ping," and frequently communica formation about what is offered to The would-be seller whose offer jected knows of course that his has been cut by some one else. invitations to manufacturers to bids throws light upon the situat a full market. These and similar dinary exchanges of bids and offe hibit the nervous system of the market. Of course the London m is always a factor.

It happens occasionally in certa riods of excitement that an agenc buy copper at a certain price and diately resell it at a difference points, or vice-versa, just as o stock exchange transactions some occur contemporaneously in the crowd at a material difference in However, such inequalities are smoothed out as conditions b calmer.

ABSOLUTE PRICE.

There is no way of determinin absolute price for copper from d day or even from year to year, as be evident from a consideration market conditions that have bee lined and discussed in this article "absolute price" I mean the a that might hypothetically be ob by dividing the proceeds of all th per sold by the number of pounds An approximation is all that can pected.

In the record of the Journal the quotation is essentially quantitat e., it is aimed to represent the b the transactions, basis New York, The small lots occasionally sold a miums figure almost disappea small when averaged in the grea ume of transactions. The monthl annual averages are simple arithn means.

Many of the producers state in official reports the amount actual ceived for their output; their av are of course quantitative indivi It is impossible to arrive at a g quantitative average because man

ducers fail to report their figures and also because those that do report employ different methods of bookkeeping. Some report the net receipts on the basis of New York, but many state the gross receipts upon delivery and debit freight and other charges in another account. The matter of interest is generally disregarded.

In any given year there is a moderately wide difference among the averages reported by individual companies. This is explainable partly by the variation in methods of accounting referred to in the previous paragraph, and partly by differences in selling. All producers are no more likely to realize the same price for their copper than are all farmers for their wheat; some sell more judiciously and alertly than others. Some may sell but sparingly on a declining market and find themselves ultimately compelled to dispose of large blocks at the lowest price, while others may be successful in the policy of reserve in the opposite way.

TWO DISTINCT SELLING POLICIES.

There have been during recent years two distinct policies in selling on the part of agencies. Some have distinctly conformed to the system of reserved selling above indicated, remaining to a large extent out of the market for long periods, unable to realize the price asked by them. Other agencies have followed the policy of selling all the time, taking the price that could best be obtained. In periods of dull, declining markets this policy of constantly pressing sales has been quite irritating to other agencies desirous of starving manufacturers into paying their price asked. The copper market has, however, been always an open one, save for the brief attempts of the Secretan Syndicate and Amalgamated Copper Company to corner it (both of which were colossal failures) and has historically obeyed the law of supply and demand. Some of the agencies take in immense quantities of crude copper under contract and they are naturally bound ordinarily to sell it more or less in the ratio of its acquisition. On the other hand the producer who is selling through an agency on commission may be more disposed to carry his output awaiting a favorable time for its sale.

While the different policies in the market may lead to materially different averages in any single year, it seems from such evidence as is available that in the long run there is no great difference in the results. This refers to the comparative experince of individual companies. Considering the results of all companies year by year a summary of the figures of those reporting publicly affords a fair approximation to a true quantitative average. A study of these figures indicates that the producers generally fall a little short of attaining the quotational average. A consideration of the psychology of buying and selling affords an explanation of this. In a declining market, frequently started by large selling by one or two concerns more farseeing than the others, the time is soon reached when buyers themselves become frightened and but little of the commodity can be marketed until speculators become interested in taking over large quantities at or near the bottom, which usually marks the turn of the tide. Upon an upward movement sales usually become smaller as the culminating point is approached. Thus in 1907 the quantity of copper sold at 25c. and upward was relatively small. The decline started with some heavy selling, but upon the long descent business was comparatively light and did not become large until 12c. and under was reached. The quantitative average in that year was extraordinarily lower than the quotational.

The manufacturers of wirebars, sheet, brass, etc., purchase wirebars, cakes and ingots. The consumers obtain their copper upon the basis of those manufacturers, the prices of which do not fluctuate in so mobile a manner as does that of the raw material. During the last four years, the average difference between wirebars and wire was 1.7c. per pound; between cakes and sheets 5⅞c. per pound. The price for wire was quoted by a pooling agreement until about the beginning of 1911. Upon the disruption of the pool the wire business became strenuously competitive and prices were cut in some cases to the manufacturing margin, which is commonly reckoned at about 1c. per pound. In general the official price for wire has corresponded with the market price for wirebars, i. e., over long periods, although at many times it has been out of tune, the fluctuations in the price for the metal not always having been quickly reflected. This has given some large users of wire an opportunity to play both markets, buying either wire or wirebars to be drawn on total according to variations from the normal difference.

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When a belt has become oil soaked and will not stay on the machine, a good method of cleaning it is as follows: Coil the belt loosely in a tub of sufficient size, and cover with whiting. Be sure that the whiting gets in between the coils of the belt, and it will be only a short time before the whiting will absorb the oil from the leather. It will then only need to be wiped clean to be ready for further service.

VANADIUM

By JAMES O. CLIFFORD.*

The great importance of vanadium in the steel industry, other manufactures and the arts has stimulated the search for deposits of vanadiferous ores of commercial value. While the occurrence of vanadium is widespread and varied, it is rarely found in such quantities as to be profitably worked.

The ores most commonly met with are the vanadates, which are usually reddish or brownish in color, unless contaminated by considerable quantities of copper, iron or manganese—in which event they may be more or less greenish or black. The following is a brief list of the more important vanadium-bearing minerals:

Vanadinite, a chloro-vanadate of lead containing 19.4% vanadic acid, is the best known vanadium mineral. It occurs in prismatic hexagonal crystals, as globular aggregates, and as simple incrustations. In color it ranges from straw yellow to deep red. Endlichite is a variety of vanadinite occuring in long, slender needle-like crystals. It differs from vanadinite by its lesser percentage of vanadic acid and higher content of arsenic pentoxide; it is, therefore, intermediate in chemical composition between vanadinite and mimetite.

Descloizite is a hydrous vanadate of lead and zinc containing about 27% vanadic acid. It occurs in short prismatic, or pyrimidal crystals; also, as a psuedomorph after vanadinite. Its color is generally clove-brown to black. Dechenite does not differ essentially from descloizite. Cupro-descloizite is a variety containing from 5 to 12% copper oxide.

Mottramite and Psittacinite are nearly identical in chemical composition and structure. In color they are greyish-green to black, and contain 9 to 20% vanadic acid.

Volborthite is an olive-green vanadate of copper, containing 14 to 40% vanadic acid. Calcio-volborthite is of a calcium-grey color and is an alteration product of volborthite in view of the replacement of the copper by calcium and barium compounds.

Pucherite, a vanadate of bismuth containing 29% vanadic acid, occurs in small orthorhombic crystals of a reddish-brown color.

Vanadiolite, a vanadate of calcium containing 45% vanadic acid, occurs massive and has a characteristic greyish-green color.

Vanadium occurs as an original con-

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* Mining and metallurgical engineer, Deming, N. M.

stituent in the rock-forming minerals mica, augite and hornblende. Roscoelite is essentially a vanadiferous muscovite of secondary origin and contains as high as 35% vanadic acid.

Carnotite, a uranyl-potassium vanadate (contaminated with calcium and barium compounds) contains as nigh as 38% vanadic acid. In color it is a canary yellow, and occurs in small pockets in sandstones. Carnotite derives its chief importance from its uranium content.

Patronite, a sulphide of vanadium from Peru, S. A., contains 60% vanadic acid. In color it ranges from dark green to black, and occurs massive. Its associated minerals are a natural red oxide and a vanadiferous asphaltite. Kentsmithite, an impure sulphate of vanadium from Colorado, occurs massive, is of steel-grey color and contains 15 to 22% vanadic acid.

QUALITATIVE AND QUANTITATIVE ANALYSES.

Qualitative Test—The borax bead dissolves vanadium pentoxide to a clear bead, colorless, or with large quantities of the anhydride, yellow in the outer flame, green in the inner flame. With large quantities of vanadic acid it appears brownish when white hot, and only turns green on cooling.

A sulphuric acid solution of vanadium pentoxide, when considerably diluted with water and treated with metallic zinc then heated, turns blue, then green, and finally from lavender to violate. Many organic substances, such as sugar, oxalic and tartaric acids, etc., reduce vanadic acid, especially in the presence of strong mineral acids, to the blue tetraoxide. The same reaction takes place when SO_2 or H_2S are added to the solution in acid. The addition of hydrogen peroxide to the blue tetraoxide occasions further oxidation, characterized by a brownish-red coloration. The hydrogen peroxide test is extremely delicate, as by its use less than 0.01% vanadium can be detected in solution.

Quantitative Analysis—Although numerous methods are given for the quantitative determination of vanadium in ores, the following—devised by J. Kent Smith, consulting metallurgist, International Vanadium Company—will be found satisfactory on nearly all vanadiferous ores

Weigh out .512 gram, or multiple thereof, of the pulverized ore. Fuse in an iron crucible with ten times sample's weight of sodium peroxide; cool and dissolve fusion in water in a 500cc. evaporating dish or casserole, using about 150cc. distilled water. Acidify with 50cc. to 75cc. to 1:3 sulphuric acid, and boil for fifteen minutes. Add until permanently pink an n-10th potassium permanganate solution, then cool. Discharge the permanganate color with a n-10th ferrous ammonium sulphate solution. By means of the potassium permanganate and ferrous ammonium sulphate solutions neutralize the solution. Then add a measured amount (excess, about 20cc) of the exactly n-10th ferrous ammonium sulphate solution. Titrate the excess of ferrous ammonium sulphate back, with an eaxctly n-10th potassium bichromate solution, using a freshly prepared solution of potassium ferricyanide on the spot plate as an indicator. The disappearance of the blue color denotes the end point. The number of ccs. of ferrous ammonium sulphate solution, less the number ccs. potassium bichromate solution, denotes the amount of sulphate used to oxidize the solution of vanadic acid; and where .512 gram sample was used, each cc. ferrous ammonium sulphate equals 1% vanadium.

METALLURGY AND ALLOYS.

The ores most commonly met with by the metallurgist are, patronite, carnotite, roscoelite and vanadinite. Numerous methods have been patented for the extraction of vanadium from the ores in which it occurs, but many of these are totally inoperative; for the reason, primarily, that vanadium has many laboratory peculiarities that are not apparent on a mill scale.

Smelting methods, with a view to subsequent recovery of the vanadium content from slag, does not offer much encouragement, especially in the treatment of ores containing less than 3% vanadium pentoxide.

Processes for the extraction of vanadium by fusion with various reagents, such as nitre, potassium bisulphate, etc., do not lend themselves to the economic treatment of low-grade ores in view of the excessive loss of reagents, additional heat required to effect fusion and the difficulty of dissolving the fused material and refining the primary solutions obtained from leaching.

While the sole method of economic extraction of vanadium from low-grade ores seems to be entirely by means of hydro-metallurgical and electro-chemical means, it must be borne in mind that expensive reagents cannot be used, nor can cheap ones be used in large excess unless a reasonably large recovery of used materials is thereafter made. Considerable progress has already been made in this connection, and we may look forward to more economical processes in the reduction of vanadium from ores and refining or vanadates of iron, calcium and copper.

The greatest difficulty encountered in the treatment of ores containing vanadium is to economically place tained vanadium in solution, f gangue. When this is done t dium will be in condition in can be readily handled.

The two leading methods of ing vanadium from its ores is ing with mineral acids, and by Better results are obtained from vanadates, which are more than vanadyl compounds. vanadates are more soluble i while vanadyl compounds in d lutions are more readily precipi the impurities present.

Patronite is treated first by to reduce to oxide, followed by position with sulphuric acid. C ores are generally decomposed ing with sodium chloride, or fix lies. Roscoelite is best treated 1:1 mixture of sodium chlor crude lye, the ore being roasted by leaching with water. Vanad to a limited degree, decomposed phuric acid. Roasting with sodi ride does not give good results. the processes in use at this tim a recovery in excess of 70% of t dium contained in ore treated.

It is as important to get vanad of solution completely as to obta plete extraction from the ores therefore necessary to precipitat the vanadium from solution in a combination and physical state for further refinement. Since t important product is ferro-vana loy, the method of preparing van iron—from which ferrovandaium ily made—is briefly stated.

The method employed in produ nadate of iron is to add ferrous to a neutral solution of sodium v Vanadate of iron is precipitated bottom of the tank holding the s this precipitate is then filter-pres dried. The vanadate of iron t tained usually contains appreciab ties of the basic salts of the ori lution, which, unless removed be ther reduction, is detrimental to t tric furnace in which it is reduce to ferrovanadium.

The various vanadium alloys from 15 to 52% metallic vanad price of $5.00 obtains per pound vanadium contained in alloys.

The basis of settlement for va ous ores varies greatly in differ tricts and with different compa very satisfactory quotation by on European buyers is: Ores cont minimum content of 10% vana command an average price of per pound V2 O5 contained, f. o. shipping point.

Mines and Methods

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CONTENTS:

Developments since the last issue of Mines and Methods makes it look as though the negotiations for purchase of a control of the Silver King Coalition company's mines at Park City would come to naught. From the information it has been possible to gather the collapse of the deal—if it does fail—can be charged to no other reason than a failure of the parties at interest to agree on a price. Mr. Howard and his engineer were permitted to make a cursory inspection of the mine about the middle of the month and, as the engineer left the city within a few hours after the trip to Park City was made, the impression gained currency that both sides threw up their hands and called it "all off." Of course there is a possibility that negotiations may be opened again in the near future, but indications, at this writing, are against it.

COPPER AND THE PUBLIC

The New York correspondent of the Mining and Scientific Press declares that, notwithstanding all the market reports tending to show the depletion of copper metal stocks, that investors in copper shares are not satisfied that the truth is being told. And then another bomb is hurled into the camp of the share market boosters by telling of John Hays Hammond's activities in the field of wireless telegraphy where the big feature of the business lies in its proclaimed tremendous economy through the practical elimination of the use of copper. These things, the correspondent says, are no small factors in the dullness of the copper share market. This is the way he puts it:

> The copper shares are still dull, in spite of much work by press agents. The investors are apparently studying the discrepancies that seem to exist between the reports from the mines and the refinery figures that are given out, and are asking "Where is all the blister copper that figures as mine output?" The market feature, both in New York and London, for some weeks past, has been a specialty that in its future depends almost wholly upon the elimination of copper as a conductor of electricity in telegraphy—the Marconi Wireless Telegraph issues. John Hays Hammond is about to attend the international wireless conference in London, and in the meantime is erecting two wireless telegraph towers on his estate in Connecticut to be used in experimental work in directing dirigible submarines in the waters of Long Island Sound. It seems odd that one of the world's famous mining engineers should act as a delegate to a conference to further a means of communication which will do away with one of the chief uses of copper when the system is fully perfected.

Another condition that is undoubtedly having its effect is the fact that, while this country and all other units of the industrial world are experiencing an era of foreboding unrest and political chaos, the copper metal and share market manipulators are insistent on "working up" prices. This they are doing in the belief tht the public will be stampeded, as it was some seven or eight years ago, when stocks went soaring in sympathy with the boost of copper metal to 26c. a pound. But the boosters are reckoning without their host. The "suckers" won't take the kind of bait that is now being offered; they got snubbed too hard before. It is all right to discourse on the absorption of copper, but the public wants to know—if it has been used—who has used it and for what purpose. And on that proposition, to the utter disgust of the boosters, the public is "standing pat," as it ought to.

The Engineering and Mining Journal of the 22, after discussing other features of the situation affecting the price of copper and copper stocks, declares that "the recent advance in copper that has been unsatisfactory to many persons, but otherwise to well-wishers for the industry, has been the NONDEVELOPMENT OF AN OLD FASHIONED COPPER STOCK BOOM. (The capitals are ours.) It is true that most of the standard copper shares have risen in about the same ratio as the metal, but there has been no public excitement carrying prices up to a basis of 5 per cent yield on 17c. copper AND THOSE WHO HAVE STOCKS TO SELL ARE DISAPPOINTED. No doubt the public will save money, because there is no probability that copper will average 17c. over a series of years, and besides the best of the copper stocks ought to yield more than 5 per cent on the purchase price.

The absence of public excitement is possibly due to an increase in wisdom, but anyway it may be attributed to SUSPICION RESPECTING THE PRESENT SITUATION. Most people are convinced that the last six months have witnessed a substantial improvement in general business, but while that has been slow and orderly, as reflected in the iron and steel markets, THE COPPER MARKET HAS BEEN CRAZY, which discrepancy has not easily been reconciled; and, moreover, the MYSTERIOUS DISAPPEARANCE of the new production of copper has had the effect of creating doubt rather than of inspiring confidence.

FRENCH VIEWS OF CHINO

French investors are not taking kindly to the attempts of American market boomers and promoters of some of our so-called "porphyry issues" to market their wares abroad. First the French sat down hard on Utah Copper for good and

sufficient reason and now, according to the news that comes through Paris financial and mining publications, they are paying their respects to the manipulators of Chino. On April 26, and again on May 3, this year, L'Argent tells its readers what it thinks of Chino in no uncertain terms. The April 26 item, translated, reads as follows:

Chino Copper—In the number of exotic values that the last raise in copper has produced, we find the Chino Copper. Of the total of 700,000 shares forming the actual capital of the company, the promoters claim more than one-half—that is, 375,000—in remuneration of their services. But, as they have a very limited confidence in the value of their mines, they say to themselves that it would be much better to imitate the rat in the hold before the ship sinks and to land with someone else the shares in their possession. It is for this reason that they attempt to unload on the French capitalist, whose pocket-book is the ideal type of the inexhaustible mine, a first slice of 200,000 shares. These shares, which have a nominal or par value of 25 francs ($5) are offered at 168 france ($33.75). That represents for the number of shares referred to, a speculation (profit) of 28,600,000 francs, or $5,720,000. The pill is a very large one and the public will have some trouble in swallowing it.

This criticism of the game Chino promoters had ribbed up for the French market followers probably called forth some "market letter" response, for on May 3 L'Argent devoted considerable space to the proposition and expresses astonishment that Chino's sponsors had the hardihood to attempt and that the Bourse representatives would permit the presentation of Chino Copper to the French public. Translated, the May 3 article handles the subject as follows:

Chino Copper—This enterprise, called porphyritic, became its tenor in metal is greatly inferior to the percentage of the true copper mines, actually offers its shares at an assessment six times higher than nominal, thus leaving to the eventual purchaser only the risk of a loss.

When a person addresses the public, one of the conditions necessary to attract attention is to present under a new form the product that he wishes to exploit. It is thus from a medical point of view that we establish a perfect evolution; in the well-to-do class, which is that of our readers, it is good taste and even snobbish to speak of neurasthenia and appendicitis; twenty years ago these two affections were simply called faintness and phlegm. One would have been ashamed to actually use these expressions, whereas now one often meets women who tell you with an air of superiority, "I have had an operation for appendicitis." This malady is indeed a privilege of a good table. It is the same from a financier's point of view—one must follow the style and, if need be, provoke it. This is what the introducers of "porphyric" mines on the Paris market have been very well understood. This work has dazzled some clerk of the exchange whose habit it is to talk a great deal without understanding anything; but whatever they may say of it, the copper industry is not yet ready to be revolutionized.

The properly called copper mines are represented by the Rio Tinto, the Boleo or the Tharsis. These exploitations treat generally pyrites or double sulphures of iron and copper, a sort of friable mineral which appears in blankets, in leads or in pockets. The mineralization is important and contains a percentage of from 3 to 3½ of metal. For several years the Americans have tried to extract from the copper the rocky masses, sort of blankets of a granitic porphyry, extremely hard, where the copper mineral chalcocite or chalcopyrite, is found irregularly disseminated in the form of little grains. The "porphyries" exploitations, instead of obtaining mineral easy to crush, require extremely powerful steam shovels to carry the rock, the hardest that exists, under crushers and to reduce it to dust. The mixture obtained passès then over screens and shaking tables where the inert matter is separated from the mineral because of the difference in densities. The mineralization does not compensate the different operations that we have just indicated, for it is expressed by the figures 1.4 or 1.6 per cent, as against 3 and 3½ for the real copper mines, as we have indicated above.

The porphyries are then incapable of competing with the European coppers, because the former make use of deposits that the latter disdain; thus the Tharsis has completely put aside a concession whose mineral tenor is only 2% copper. The American mines remain inferior from a mineralization standpoint. Besides, as the preparatory operations are much more tedious, their exploitation can only produce defective conditions; the price of the net cost of copper reached, in fact, the figures $180 (900 francs) and $200 (1000 francs) a ton at the time that the Spassky, situated in the heart of Siberia, 800 kilometers from the nearest railway, a distance that had to be traversed by carts or camels, offered the same metals at the rate of $180 (800 francs) a ton.

Under the circumstances we are astonished that they could actually present to the French public the Chino Copper stock. This stock, the nominal price of which is $5 or 25 francs tries to get into our pocket-books at $33 (165 francs) and $33.60 (168 francs). On a capital of $4,000,000, or 20,600,000 francs the Bourse here permits for the 800,000 shares a speculation of $22,280,000 (111,400,000 francs). It really makes one think that the credulity of the parsimonious buyer is fathomless and as limitless as infinity for these people to have the audacity to propose to him a slice of this size. Independent of the capital stock, there exists a mortgage debt of 12,500,000 francs in bonds at 6% which do not appear in the balance sheet of December 31, 1190, the only one, up to now, that the promoters have dared to show us, for it must be singularly difficult to find a real counterpart of this new sum in the assets of the company; the accountant of the company is surely forced to increase enormously its supply and stock of mineral. * * *.

UTAH COPPER'S GYMNASTICS

Seeing that the addition of 100,000,000 tons of new ore to the reserves of Utah Copper during the year 1911—as recently confided to the world in the company's annual report—had no effect on the market price of the company's shares, it is respectfully suggested that the management tell to what extent its "porphyries" are swelling this year, in semi-annual installments. Why not state, during July, that 50,000,000 tons have been added so far this year. According to previous figuring that would add about $65 more to the value of each share and might advance the market price 25c. or 50c., particularly if copper continues to soar as it has been doing every minute since the last annual report was issued. And whether such a statement advanced the market price of the shares or not, see how much sounder the "fundamental" and "statistical" position of the company would be. After the proposed 50,000,000 tons was added to the "blocked out" reserves, there would still be, according to the estimates of George L. Walker, about 150,000,000 tons more, in the gambler's parlance, to "nigger" with.

Arguing along the modest and shy lines that characterize the daily press and brokerage "market letter" utterances, Utah Copper had developed ore representing approximately $100 a share previous to 1910, for its present capitalization; $250 a share was added to that during 1910-11; the development of another 100,000,000 tons of ore this year would tack on another $125 per share in value and there would still remain another 100,000,000 tons—another $125 a share—for next year, thus rounding out Walker's estimate and giving the shares a real, dyed-in-the-wool-intrinsic market value of $600 a share. SO THAT THE INSIDE INTERESTS WHO ARE NOW STRAINING EVERY NERVE TO MAKE A MARKET THAT WILL PERMIT THEM TO UNLOAD must be willing to sacrifice about $540 a share in order to grab $60 in REAL MONEY per share. Funny, isn't it.

COPPERETTES

"Neither Utah Copper nor Navada Consolidated have EVER been active traders," says the well posted New York correspondent of the Mining and Scientific Press. But we fear that he does not read the list of "sales" of Utah Copper sent out from the New York "laundry" every day.

* * * *

It is reported to us that no underground-mined ore was treated in the Arthur plant of the Utah Copper Company during May, the reason given being that it was too hard to treat. Now what do you think of that? This mill was reconstructed to make it conform to the high standard (?) of the Magna plant—and now it won't work!—that is, it won't chew up tonnage fast enough to suit the management. Tonnage is what exigencies demand at both the Arthur and Magna mills all the time; recoveries are of secondary moment, because "copper is the cheapest thing we've got."

* * * *

Enriched by the "underground tonnage" from the Boston Consolidated Barnsdall properties of the Utah Copper mines, the rock put through the Magna mill during the month of May is reported to have run between 1.4 and 1.5% copper. The mill's recovery, it is reported to Mines and Methods, amounted to 52%. All of the steam-shovel product of the Utah Copper mine is now probably coming from what is likely to be designated in some of the future reports as "near ore," because the "partially developed" ore goes 1.28% copper without any "sweetening" from underground workings, all of which must have been mixed with the Magna feed last month.

MINING THE MAINSPRING OF INDUSTRIAL SYSTEM

By JAMES RALPH FINDLAY.*

Scientific understanding of natural forces underlies a prodigious expansion of industry and wealth. What does that wealth consist of? In the main it consists of marvelously improved vehicles of communication and travel; telephones, telegraphs, railroads, automobiles, elevators, and steamships; of comfortable and safe abodes built very often of steel and concrete; of innumerable factories capable of supplying nearly every luxury or utility we can think of. Our wealth consists of our ability so to use the natural elements of light, heat, gravity and chemical reactions that each man no longer has at his service merely the muscular effort of his own body and of the bodies of horses and cattle, but such great energies that with their aid one man may do what formerly required 10 or 20 men to do.

I wish to draw your attention to the fact that practically all the means for these accomplishments are supplied by our mines. We dig out of the earth not only our materials but our energy. The modern ship is as good an example as any. She is wholly built of and propelled by the products of mines. The energy which makes possible the very process of building is supplied by mines for almost every lathe and riveter in the world is driven by steam which is furnished by coal.

How shallow then is the idea so often entertained, and so casually expressed that the business of mining is a kind of gambling from which the prudent business man should carefully shy away! On the contrary mining is the mainspring of our whole industrial system.

What I wish to inquire into, is how far has this particular effort of civilization been accomplished. Have we gone nearly as far as we shall ever go in finding uses for minerals? Or is there still a vast field for expansion ahead? It is too big a question to be answered more than partially. It is plain enough that the expansion is still in full progress and that it is too big a movement to be stopped suddenly. This can be easily ascertained by the most casual inquiry into the facts, but it is a different and more difficult question when we come to look at it in its larger aspects.

We must expect some limit to the increasing use of minerals. The main cause for increase is the rising consumption per capita in the great industrial nations. In 1850 each person in the United States used 1028 lbs. of coal and about 75 lbs. of iron; in 1910 each person used 11,000 lbs. of coal and 600 lbs. of iron. How this enormous increase of consumption has taken place since a date when the age of steam and iron was already well started. Even in 1860, steamships went regularly between the principal parts of the world, railroads already connected the principal cities and steam engines were driving the principal factories. Yet in the 50 following years the use of coal increased ten fold. We have added in that time electric lighting, electric railroads, steel buildings, cement pavements, power elevators, automobiles, power-driven machinery, ocean cables, wireless telegraphs, and innumerable other avenues for the consumption of metals and of power.

If such an expansion is to continue for another 50 years we shall be using minerals with a lavishness that staggers the imagination. If it does continue then each person will use 120,000 lbs. of coal and 5,000 lbs. of iron every year with other things in proportion. Allowing for the increase of population such figures would mean a consumption of ten thousand million tons of coal and four or five hundred million tons of iron annually in the United States alone. This seems incredible and utterly out of the question. In other words I believe that the enormous expansion in the use of minerals will soon begin to slacken.

I said a little while ago that there is no present evidence of slackening. My idea is that approximately the same causes which are producing the general increase of population and particularly the growth of enormous cities are behind the great expansion in the use of minerals. The cities grow because transportation is easy and quick; the largest cities grow especially because the perfection of communication allows certain forms of business which otherwise might be scattered all over the country to be carried on to best advantage in the largest city. New York for instance is growing on a multiplicity of small manufactures. Forty odd per cent in number of the new manufacturing enterprises of the country are located there, but the average number of employes is only 24. Undoubtedly this goes on because a great center of population supplies artisans for each specialty, and because the city itself is the greatest single market. The highly improved transportation facilities naturally act to better advantage in carrying articles from big markets to lesser ones, than from lesser markets to big ones for a variety of reasons that will occur to everyone.

The general increase of population is without doubt due to the same causes. This increase is taking place only in the great industrial nations or in regions controlled by them. The improvements in the means of getting a living, the stoppage of useless wars and disorders, the stoppage of plagues and famines have all been caused by improvements in transportation and production. These agents have afforded populations which had been brought to a standstill by restricted living conditions another chance to grow.

But in the center of the world's civilization we find a great nation where the population is not increasing. I mean in France. The census figures show a marked decline in the birth rate also in the United States, and I believe the same facts are beginning to appear in England. An enormous and continued increase of population is I think generally taken for granted. As a general fact it cannot be disputed; but its unlimited continuance is a manifest absurdity, for a few centuries of increase like that of the past 50 years would multiply the human race until there would not be standing room. A check is inevitable, and I believe it is already perceptible.

Similarly we can find reason to expect a check to the growth of cities. This will come from the working out of the present cycle of industrial development. Whenever the perfection of transportation shall have brought all the people to the great cities who can profitably go to them in the pursuit of business or pleasure the disproportions to growth of those cities will cease.

My idea is that the most highly civilized, or at least most active industrial nations may be already somewhere near their maximum productively, although they certainly have not reached it. There are forces in action now which are plainly still adding to the industrial activity of the average man. While I don't pretend to have any special knowledge of mechanical matters I take no risk in stating that not one of the great systems of power utilization has reached its full development. I mean that a given million people are not yet fully supplied with electric lights, telephones, automobiles and other comforts and luxuries. To illustrate this I will give one or two specific examples. A classmate of mine is connected with the Boston Edison Electric Co. He told me that in 1896 that company had a total of 200,000 lights on its circuit. In 1908 it was adding lights with-

*Abstract of annual commencement address, Missouri School of Mines, May 31, 1912.

in the same territory at the rate of 200,000 each year, and expected to continue doing so for many years to come.

The practical gas engine is barely 20 years old but in that short time it has revolutionized certain forms of industry and is rapidly revolutionizing, through the automobile, what we may conveniently call neighborhood transportation. It has also made real a dream of many ages—the navigation of the air. But it occurs to me that any specific thing accomplished by the gas engine is of minor consequence compared with the fact that through it high-class machinery has become a plaything. It seems to me this may indicate that with us at least the great cycle of industrial development may be approaching its culmination. Let us dwell on this idea for a moment.

Water wheels have supplied industrial power for thousands of years, but, because no means had been invented for transmitting that power, that form of machinery was chained down to certain localities. The invention of electric transmission removed that shortcoming and the power from water wheels is rapidly becoming more usable. But generally speaking the manipulation of electrical machinery remains in the hands of the specialist; and certainly up to the present the mass of the people have not been accustomed to use machines driven by water power. The steam engine has been in use for about 125 years. Its usefulness has been and is stupendous, but the necessity of providing with each unit a cumbersome boiler has always confined its use to trained specialties. To be sure the use of both steam and of electricity has been gaining ground ever since they were made practical, but after all it remained for the gas engine to bring high-class machinery into the hands of the average man. There is enormous significance in this fact. Heretofore industrial efficiency has been growing because the use of machinery has been spreading from one class of people to another and from one industry to another. It has been growing because it could spread. When the use becomes universal there will be no such chance to spread. I am inclined to think therefore that we are within striking distance of the time when the highly civilized and creative nations will have put as many power-using devices into the hands of their citizens as they can use. Now since the principal use of minerals is to provide the means of utilizing power I argue that the consumption of minerals will reach its maximum amount per capita at the same time.

I will state the case in concrete form. Every person in the United States uses 600 lbs. of iron each year, and uses more each year. I would not like to state a figure of how much each person will ultimately use, for that would be mere guesswork; but we may be very sure that the amount will increase at least as long as the percentage of people who run automobiles increases. Since that point ought to be reached in a decade or two I argue that each person will increase his consumption of iron for that long, but not much longer. Let us see what this will mean to the steel business. In 1900 each person used 400 lbs.; in 1910, 600 lbs. At this percentage rate by 1920 each person would be using 900 lbs.; but suppose that the present decade is the culmination of the great power-using cycle, that the percentage rate will not be maintained and that the amount of iron used by each person increases only by the same number of pounds as during the last decade. We should by this calculation allow 800 lbs. per person in 1920. The population of the country by that time should be 110,000,000. The amount of iron manufactured by that time should be about 44,000,000 tons, against 26,000,000 in 1910.

Allowing that during the following decade the consumption would increase only 100 lbs. further per capita and allowing for the increase of population, the output in 1930 would be 60,000,000 tons.

What I am driving at is to put before you some ideas about the prospects of the mining business. One question for a young man to consider is what hopes to entertain. There is no use going into a form of activity which you do not believe in. I have used the figures just stated because I believe that they give a fair idea of the growth which may be expected in the mining business in the immediate future. It is perfectly fair, even conservative, to expect that the consumption of all mining products will double inside of 20 years.

I have had in mind thus far the progress of our own country only; let us consider the rest of the world a little.

The active industrial nations constitute today only a fifth, or perhaps a quarter of the human race.

We may specify only Great Britain and her English speaking possessions, Germany, Austria, Italy, France, Norway, Sweden, the Netherlands, and the United States as the really active industrial nations. The rest of the world is not altogether without the knowledge of power-driven industry, but its knowledge as yet is only borrowed and its application sporadic. If the whole race used iron as fast as the people of this country the annual consumption of the world would be at least seven times what it actually is. Now I conceive that the industrial ideas of Europe and America are sure to be adopted in some form or other by all other peoples until they become universal, just as agriculture in earlier times must have spread from some source until it became universal. One would be bold indeed to say when all this will be accomplished, for nations and races have an obstinate way of working out their own destines in their own way, but the events of the last few years contain many striking signs of the stirring up of intellectual life in Asia. Turkey and India have shown in different ways a capacity and desire for advancement. In India for instance a large steel plant has been started with native capital.

When we come to that word capital we reach one of the stumbling blocks of those nations that are industrially backward. According to many of our advanced labor unionists, capital and capitalism are the source of grievous economic injustices. Perhaps that is true, but whatever evils lie in the existence and domination of capital are surely counterbalanced by benefits that cannot exist without capital. I have lived in countries where there was little or no capital. There was likewise little or no industry, little or no security, little or no labor and mighty low wages. Capital is the symptom and the product of good morals, good government and fair dealing, as well as of energy and natural resources. It cannot exist without a general confidence in the integrity and ability of other people. Modern industry is most emphatically co-operative. The business or the enterprise owned by an individual is now a rare thing. The industrial unit is now the corporation, and that is created only by joint action and joint capital. People who are afraid to trust each other cannot form corporations and cannot participate very much in the best efforts of modern civilization. The progress of industry therefore in some countries may have to wait until the people prepare themselves for owning capital.

But at any rate there is an immense field for the further development of industry throughout the world. It is a fair presumption that the nations that are ahead now will continue to be ahead for some time. Undoubtedly they will find considerable business in furnishing the backward nations the facilities for making a start.

The proposition of mining with reference to the development of civilization and of industry is plain enough. The importance of minerals as the materials for industry has been steadily growing and must continue to grow. In our own country we may be somewhere near the point where we have as much mineral wealth per capita as we car for, but in the world is still far off.

LEACHING APPLIED TO COPPER ORE* (XIX)

ELECTROLYTIC DEPOSITION OF COPPER FROM SOLUTIONS (CONTINUED)

By W. L. AUSTIN.†

It has been repeatedly observed that in the electrolytic precipitation of copper from solutions with the help of insoluble anodes, iron salts under certain conditions interfere with the operation. Ferric salts produced at the anode attack copper deposited on the cathode, unless some means is taken to prevent their formation, or else to obstruct diffusion, should they be formed. Furthermore, iron present in an electrolyte is deposited with the copper when the voltage unduly rises owing to polarization. It is also readily deposited from a bath containing ferric sulphate, because this is decomposed at a lower theoretical potential (1.62 volt) than the ferrous salt (2.02 volts). This is particularly the case when basic salts are formed through lack of circulation in the vat. The theoretical potential necessary to electrolyze cupric sulphate is 1.20, it being understood, of course, that, as with the foregoing voltages given for iron compounds, reference is made to electrolysis using insoluble anodes. Owing to causes stated it is evident that iron salts can under the given circumstances not only materially reduce current efficiency but also contaminate the copper. Recognizing these difficulties, some inventors have devised means for eliminating ferruginous salts from the electrolyte as far as possible; but as iron is usually present in ore, more or less of that element always finds its way into the bath.

USE OF A DEPOLARIZER.

In electrolyzing a copper sulphate solution, using an insoluble anode, oxygen is evolved at the positive electrode. The sulphuric acid produced by combination of the acid radical with water at the anode is also electrolyzed with evolution of hydrogen at the cathode. These two gases, oxygen and hydrogen bring about counter-EMF which can reach formidable proportions. Several inventors have sought to overcome this disadvantage by introducing a depolarizer into the bath. Sulphur dioxide contained in the gases from ore-roasting furnaces is a convenient depolarizer for the purpose, as it combines with oxygen liberated at the positive electrode producing sulphuric acid. Reinartz demonstrated in his experiments that from 60 to 65 percent of the oxygen liberated at the anode can in this manner be brought into reaction with sulphur dioxide. Besides depolarizing, the acid accumulating in the bath lessens its ohmic resistance when otherwise it would increase as copper is removed by deposition on the cathode.

Another advantage gained by increasing the acidity of a bath through the introduction of sulphur dioxide gas is, that iron and zinc are not readily precipitated from such solutions and therefore the cathode copper is purer. These matters were discussed in Mines & Methods, Vol II, pp. 281-284, and the experimental data furnished in the article referred to should be of assistance to any one engaged in electrolyzing copper sulphate solutions with insoluble anodes. Referring to the tables given by Reinartz it will be noted that a considerable voltage was employed in those experiments when the electrolyte contained but little free sulphuric acid. It is also apparent that in treating impure solutions (amperage remaining constant) the electromotive force necessary to maintain the desired current-strength fell steadily as copper was removed from the bath and free acid accumulated in it. This was not so marked when iron was absent, as is shown in Table II. This fact taken in connection with other phenomena to which attention was called in the article referred to, indicates that the presence of iron salts is an advantage when sulphur dioxide is used as a depolarizer.

It was shown in the preceding article that the average EMF theoretically necessary to remove copper from the 0.01-normal copper-sulphate bath under the conditions stated, can be estimated at approximately 4.93 volts—with electrodes 3 cm. apart and assuming all the copper to be removed in course of the operation. In Reinartz' experiments the weakest solution employed contained 2.54 percent copper $=6.38$ percent $CuSO_4$, which would be 0.8-normal, and this strength of solution was found to require a pressure of 1.9 volts. The electrodes were, however, 7 cm. apart at nearest point, with probably an average distance of 10.4 cm. because of the circular cathodes. To compare the theoretical results obtained in the first case with the experimental figures given by Reinartz, both must be reduced as nearly as possible to a common basis. To do this the first step to be taken is to ascertain the respective resistances offered by the two solutions to passage of the current.

COMPARISON OF METHODS.

The resistivity of 1 cm. cube 0.01-normal solution is 1394 ohms, whereas that of normal solution is only 39 ohms, the ratio being as 36 to 1; but the respective distances between the electrodes in the two cases are as 3 to 10.4. Three times $1394=4182$ ohms represents the resistance between electrodes in the case of the 0.01-normal solution, and 10.4 times $39=406$ ohms would be approximately that encountered in the Reinartz experiment. Therefore the ohmic resistance of 0.01-normal bath would be approximately 10.3 times that of a normal bath for equal cathode surface, notwithstanding closer proximity of the electrodes. As a matter of fact the ratio would be less than 10.3 because the resistivity of 0.8-normal solution is greater than that of a normal one; but on the other hand there was a considerable amount (quantity not given in the original) of free sulphuric acid in the bath, which would greatly lessen the resistance. Taking the working surfaces of the revolving cathodes at 819 sq. cm., and the current at 5 amperes as stated, the current density would be $\frac{5}{819} =$ 0.0061 amperes per sq. cm. To obtain the EMF necessary to drive 0.0061 amperes through a resistance of 406 ohms, the first must be multiplied by the second—$0.0061 \times 406=2.48$ volts. This would have been the pressure necessary had the solution been normal; but conductivity was improved by the free sulphuric acid added to the solution, and this, taken in connection with the development of auxiliary EMF through oxidation of sulphur dioxide to sulphuric acid at the anodes, benefitted the operation to such an extent that actual work showed 1.9 volt sufficed although ohmic resistance of the 0.8-normal solution should have been greater than of a normal one.

Taking the cathode surface in operation at 819 sq. cm., the resistance of one cm. cube of Reinartz' bath of mixed copper and iron sulphates with sulphuric acid must have been (assuming the average distance between electrodes to

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have been 10.4 cm.): $\frac{1.9}{0.0061} \times \frac{1}{10.4} = 30$ ohms. It has been shown in the article previously mentioned that current efficiency (as represented by cathode copper deposited) was 90 percent. The amount of current consumed in depositing 75 grams (=0.165 lb. avd.) of copper was 1.9×5×15=142.5 watt-hours, or 0.1425 kilowatt-hours, which is equivalent to 1.157 lb. copper per kw-hour. At a cost of one cent per kw-hour, the expense in depositing 1.157 lb. copper would be $0.0086 per lb. This sum is less than half that estimated as required in the previous example.

To sum up. In the first example a weak solution containing 0.03 percent of copper sulphate was used, which had a high resistivity, and the electrodes were placed 3 cm. apart. In the second example the solution contained 2.34 percent copper, but the electrodes were 10.4 cm. distant from each other. In the second case a depolarizer was used. In the first place under the conditions assumed the expense was two cents per pound copper deposited; in the second it was less than one cent, and at the same time a strong solvent liquor was prepared for use in extracting metal from new material. It follows, that in depositing copper electrolytically from sulphate solutions, employing insoluble anodes, there is manifest advantage in using fairly concentrated solutions, as also in introducing a depolarizer. The experimental data supplied by Reinartz' researches are of special value in illustrating the advantages of depolarization. It will be noted in the Reinartz experiments that use of a diaphragm was dispensed with because it was found that sulphur dioxide prevented formation of ferric salts at the anode. The iron in the bath was, therefore, beneficial in that it assisted in converting sulphur dioxide into sulphuric acid. It should be further noted that in many of the Reinartz experiments the current efficiency at the cathode amounted to 100 percent.

VALUE OF THERMAL CALCULATIONS.

The principal value of calculations such as those given in the foregoing lies in their affording a basis for estimating the comparative efficiency of different methods—for instance, the relative costs of deposition by electrolysis or cementation are readily calculated; also the approximate expense of electrolyzing solutions of varying copper content. Or the relative amenability to electrolysis of cupric and cuprous chloride solutions as compared with each other, or with cupric sulphate, can be approximately shown. A rough estimate of the amount of power required for a given purpose is also possible; but to the result reached *through* recourse to thermochemical data it is always necessary to add a surplus to provide for consumption of power from sources other than those calculated upon purely thermochemical lines. When the bath is fresh and the anodes are new, an operation may proceed approximately according to theoretical estimates; but after a while the consumption of energy in a bath creeps up, when solutions derived from ore leaching are electrolyzed without introducing some auxiliary.

Among the causes which conspire to increase consumption of electromotive force is the change in concentration of solution in proximity to the cathodes, unless good circulation is maintained. As copper is extracted from the bath the catholyte is correspondingly diluted, and weak solutions interpose greater resistance. Then films of gases which collect on both electrodes set up a current which flows in the opposite direction to that of the main one. Even the metal deposited on the cathode when not firmly adherent, interposes resistance. When solvents of copper, such as the ferric salts, are permitted to reach the cathode, the work of the current is partially nullified by the metal going again into solution. Then the contacts and conductors absorb energy. In estimating current absorption in electrolytic copper refining, where, of course, soluble anodes are used, loss in the dynamo has been given as 10 percent, and that in the conductors as 22 percent, so that with current efficiency 90 to 95 percent of the theoretical, only from 62 to 66 percent of the energy consumed finds useful application.

As to choice between salts of the metal to be subjected to electrolysis, there is not much difference from the point of view of EMF necessary for their decomposition. Taking the respective heats of formation of copper sulphate and chloride as represented by the following thermochemical formulae, and dividing each by the valency of copper when present as cupric salts, the following quantities of energy represented in calories are found necessary for their decomposition:

[Cu, O, SO^3aq] $= \frac{55,960}{2} =$ 27,980 calories.
[Cu,Cl^2] $= \frac{62,710}{2} =$ 31,305 Calories.

Now one volt-coulomb (= one joule = one watt-second) is the electrical unit of *energy*, and has been determined by experiment to be equivalent to 0.239 calories. To decompose the sulphate and chloride of copper requires the application of as many electrical units of *energy* as are respectively represented by the following equations: $\frac{27,980}{0.239} =$ 117,071, and $\frac{31,305}{0.239} =$ 130,983 volt- coulombs. An electrical unit of *energy* can be expressed as the product of two factors, one being of the nature of a *quantity* and the other of *pressure*. A coulomb (= one ampere flowing for one second) is the unit of *quantity* of electricity (not of energy), and by experiment it has been determined that 96,540 coulombs is the *quantity* of electricity associated with a gram-equivalent of any univalent element, or with half a gram-equivalent in the case of a bivalent. This quantity of electricity will suffice to separate half a gram-equivalent of copper from either of the bivalent salts above mentioned; but, as shown in the number of heat-units absorbed in their formation, it requires more energy to break up the combination of elements composing one of these salts than it does the other. Were the heat of formation of a given salt, as determined from thermochemical data, represented by exactly 96,540 volt-coulombs (=96,540 amperes flowing for one second at one volt pressure), then the voltage necessary to decompose this combination would be clearly one volt. It follows that if the energy as given in volt-coulombs is either more or less than 96,540, the voltage required to break up the combination will be proportional to the number of times 96,540 is contained in the figures representing the said energy. In the cases of the two copper salts under consideration, the theoretical voltages necessary for their decomposition are respectively $\frac{117,071}{96,540} =$ 1.21 volt, and $\frac{130,983}{96,540} =$ 1.36 volt.

VOLTAGE REQUIRED TO ELECTROLYZE CUPROUS CHLORIDE.

Where copper is univalent, as with cuprous chloride, the theoretical voltage required would be greater than in either of the foregoing instances, as is evident from the following. [Cu, Cl] $= \frac{32,875}{1}$ =32,875 calories = heat of formation. The energy necessary to break up this combination, expressed in units of electrical energy is $\frac{32,875}{0.239} =$ 137,552 volt-coulombs. From which follows that the theoretical voltage necessary to carry out the operation is: $\frac{137,552}{96,540} =$ 1.42 volt.

Although one ampere of current separates 1.1 gram of bivalent copper per hour, and double that amount of metal from a univalent copper combination, the energy required to separate equal amounts of metal from the two salts is evidently not also in the ratio of one to two. It was shown above that 96,540 coulombs at 1.36 volt pressure is the theoretical amount of energy necessary to deposit half a gram-equivalent of copper from a bivalent salt, while in the case of the univalent combination the same quantity of electricity at 1.42 volt will separate a whole gram-equivalent. Therefore, to separate equal amounts of metal from cupric and cuprous solutions will call for an expenditure of power in

proportions 2.72 to 1.42. Reduced to centages, the energy theoretically necary to deposit copper from a cuprous is only 54 percent of that required to osit the same amount of metal from upric, assuming the heat of formation be 32,875 calories: taking the caloripower at 35,400 calories, as given by e authorities, the voltage required decomposition of this salt would be energy would be 57 per cent. , and the corresponding expenditure energy would be 57 per cent. will be shown later that the operation depositing copper from cupriferous utions is more complicated than is icated in the simple reaction 2CuCl Electricity=Cu+$CuCl_2$, and that the ults given require to be modified.

n the Hoepfner process, to which erence has been repeatedly made in se articles, copper is dissolved out of ore by means of a solution of brine rying cupric chloride, the cupric salt ng the active leaching reagent. The ultant liquor is electrolyzed in vats, anodes and cathodes being separated diaphragms. Upon entering the vats liquor is divided into two streams, e flowing through the cathode comrtment, the other through the anode. e Hoepfner process was very carefully ought out, and was intelligently aplied. It is essentially a chlorine process, and was thoroughly tested upon a orking scale at several places. Its history, therefore, reflects much light upon e application of chlorine lixiviants to re-leaching operations. In lixiviating ny ordinary copper ore with a solution f electrolyzed cupriferous brine, natually more or less iron will be taken up hich cannot be profitably eliminated, o that the electrolyte must necessarily e ferruginous. Judging from the published accounts of the practical working f the Hoepfner process such was found o be the case, and means were devised or removing iron salts when they acumulated in too large quantities.

THE HOEPFNER PROCESS.

Cupric chloride ($CuCl_2$) in attacking mineralized copper is converted into uprous chloride (CuCl) which is dissolved in the excess of brine present, and therefore the liquors flowing through the electrolytic vats carry the metal in he cuprous state. In the cathode compartment copper is deposited, while in he anode compartment an equivalent uantity of CuCl is raised at the same ime to $CuCl_2$. Considered from the tandpoint of thermal chemistry, and eglecting heats of solution, the energy bsorbed in these reactions should be as llows:

$[Cu^2, Cl^2]$=65,750 calories absorbed.
$[Cu, Cl^2]$=51,630 calories liberated.

Difference 14,120 calories absorbed.

These figures represent, however, the energy required to decompose two gram-equivalents of the cuprous salt, and to form one gram-equivalent of the cupric chloride. Both, therefore, require two Faradays for their decomposition, or what amounts to the same thing, both must be halved before dividing by 96,540 volt-coulombs. It follows that the voltage necessary to carry out decomposition of CuCl in the cathode compartment, with formation of $CuCl_2$ in the anode compartment, will be theoretically: $\frac{14,120}{2} \times \frac{1}{0.239} \times \frac{1}{96,540} = 0.3059$ volt. In addition to the voltage necessary for chemical reactions, there will be required EMF to overcome omhic resistance of electrolyte, contacts, diaphragm, and conductors.

To compare the theoretical working of a Hoepfner cell with the results obtained by Reinartz previously mentioned, let it be assumed that the distance between electrodes is 10.4 centimeters, and that the active cathode surface is 819 square centimeters. One hundred cubic centimeters of a 15 percent NaCl solution at 14° Celsius will hold in solution 3.5 grams cuprous chloride, and such a solution at 18° C. has a resistivity (ohmic resistance of one cubic centimeter) of 6.1 ohms. Therefore the ohmic resistance of 819 sq. cm. cross-sectional area of the saline liquor (disregarding salts of copper, iron, and other metals) would be $\frac{6.1 \times 10.4}{819} = 0.0774$ ohm. Taking the current density at 0.0061 amperes per sq. cm., or 5 amperes for the 819 sq. cm., the voltage necessary to overcome ohmic resistance of the cell would be $0.077 \times 5.0 = 0.387$ volt. The theoretical voltage absorbed between electrodes in one cell would be therefore $0.3059 + 0.387 = 0.6929$ volt, and adding 0.2 volt for resistance at contacts would bring the total up to 0.9 volt.

To arrive at the theoretical amount of copper deposited in one day, it is necessary to multiply the quantity, (2.368 grams) deposited by one ampere in one hour from a univalent combination, by the number of amperes of current passing through the apparatus: 2.368×5 amperes $\times 24$ hours = 284 grams = 0.62 lb. avd. per day. Five amperes flowing at 0.9 volt pressure for 24 hours=0.108 kilowatt-hour, and the quantity of copper deposited per kw-hour is: $\frac{0.62}{0.108} = 5.74$ lb. avd.

THEORY AND PRACTICE.

This result is merely an approximation, of course, because a statement of all the factors which enter into the equation is not available, but it is interesting to compare it with results said to have been attained in the practical working of the process. In one instance it was stated that in practice the actual EMF found to be required was from 0.6 to 0.8 volt, and that with a current (=0.0025 amperes per sq. cm.) of cathode surface, in 24 horse-power hours strength of 2.3 amperes per square foot (=17.9 kw-hours) deposited 133 lb. copper. This would be $\frac{133}{17.9} = 7.43$ lb. of copper per kw-hour. Now, 2.3 amperes flowing for 24 hours at 0.6 volt pressure equal 0.03312 kw-hour. But 2.3 amperes will deposit in that time $2.372 \times 2.3 \times 24 =$ 131 grams (=0.29 lb.) copper. Therefore, theoretically 0.03312 kw-hour should have deposited $\frac{0.29}{0.03312} = 8.75$ lb. copper, so that the actual cathode efficiency as stated is 84.9 percent of the theoretical.

The result given compares very favorably with those obtained in electrolyzing sulphate solutions, and it is easy to understand why methods designed to extract copper from ore as cuprous chloride, with subsequent electrolysis of the cuprous solutions, should have received so much attention. The question naturally arises, why have none of these processes achieved lasting commercial success?

In the case of the Hoepfner process, the fact that the patentee found it desirable to take out several patents subsequent to the main process patent, having for their objective the removal of iron salts from the liquors, indicates that these interfered seriously with this method of ore reduction. That he also had difficulties with his anodes and diaphragms is shown by patent applications for improvements designed to meet such troubles. Furthermore, while cupric chloride will attack copper sulphides, it is nevertheless a weak reagent, and must in consequence work very slowly. To handle a large quantity of ore would necessarily require a plant of considerable proportions, so that the tardiness with which the solvent works, together with the cost of additional apparatus used in purifying liquors, would offset in a measure the theoretical advantage to be gained by electrolyzing the cuprous salt.

If the attempt is made to increase the solvent-power of the lixiviant by raising the voltage in order that chlorine shall be liberated at the anode, then a number of other reactions take place which complicate the situation. Taking the calorific power of [Na, Claq] =96,510 calories, the theoretical voltage necessary for its decomposition is $\frac{96,540}{0.239} \times \frac{1}{96,540}$ =4.18 volts; but in solution, owing to formation of NaOH this is reduced to 2.29 volts. At this pressure, augmented by that necessary to overcome ohmic resistance, the brine of the bath will be decomposed, hydrogen appearing at the cathode and chlorine being liberated at the anode. But long before this point is reached, ferrous and ferric sulphates and chlorides will be subjected to

electrolysis, as will also cupric chloride and sulphate. Ferrous chloride is electrolyzed at (theoretically) 2.16 volts, and cupric chloride at 1.36 volt (1.6 volt is given by one writer), if, therefore, the ohmic resistance of the circuit is increased in any manner whatever, so that it reaches the point at which ferrous chloride is decomposed, then ferric iron will appear in the anolyte and metallic iron will be deposited on the cathode with the copper. Even when the EMF is raised only a little above that required to decompose cuprous chloride, cupric chloride is attacked with evolution of chlorine.

COPPER REFINING DIFFERS FROM COPPER EXTRACTION.

Working with insoluble anodes and a diaphragm, and a constantly changing electrolyte, is not such a simple operation as where soluble anodes are employed, for instance, in electrolytic copper refining. In the latter process the composition of the electrolyte is practically constant, and polarization is not to be feared. The probabilities are that the rocks upon which the Hoepfner process split were, weakness of lixiviant, uncontrollability of voltage, and shortcomings in the mechanics of the electrolytic cells themselves. A paper written by E. Jensch, and published in Chem. Zeitung for 1894, page 1906, goes into the difficulties which arose when attempts were made to put this process into commercial operation.

Attention has been repeatedly called in these articles to the unsatisfactory results obtained when depositing a metal electrolytically in the same apparatus in which a lixiviant for that metal is being generated. Any method of ore-reduction undertaking to carry out such a scheme is heavily handicapped, just as is the case with a smelting furnace designed to smelt ore in the upper part and bessemerize the resulting matte in the crucible. Both operations may be successfully carried out separately, but interfere with each other when performed in one and the same piece of apparatus. In the case of electrolysis, the problem confronting metallurgists would be greatly simplified if deposition of the metal, and preparation of the solvent, were considered from the standpoint of two separate operations. This statement may possibly have to be modified when applied to processes employing a depolarizer, but these methods have yet to be demonstrated upon a commercial scale.

The whole subject of electrochemistry was literally in its infancy some twenty-five years ago, and its applicability to ore-leaching operations has not yet received due attention on the part of men financially able to carry experiments from the laboratory through to commercial demonstration. Entirely new electrochemical methods have been discovered in late years for separating metals, not only from each other, but also from ore. Along some lines the art of electrometallurgy has met with encouragement, so that now many of the most valuable metals are obtained almost exclusively by electrical methods. Electrometallurgy of copper has been held back, however, through the failure of the old, purely chemical processes to meet modern conditions, as well as by the impractical methods advocated by some of its devotees.

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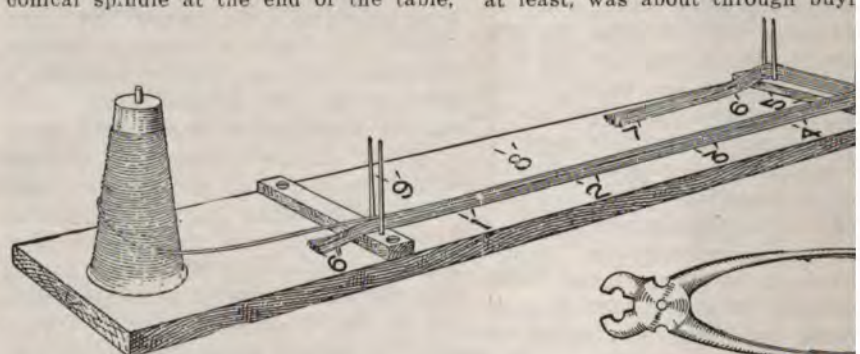
TABLE FOR CUTTING FUSE

The accompanying drawing shows the design of a table for conveniently cutting fuse. It is used at the Blackberry and Montana mines, near Joplin, Mo. The coil of fuse is carried on a conical spindle at the end of the table,



and from this spindle the fuse is unwound as it is measured. The fuse is held between a series of two 60-d. nails driven into two cleats of 1x2-in. wood that are screwed to the table. The cutting is done six inches ahead of the first pair of nails, so that there are no long, loose ends in the way. On the table are marks which are used in measuring the several lengths of fuse usually required.

In cutting the fuse, the loose end from the coil is run through the first pair of nails, taken around the turning nails, passed through the last pair of nails that hold the loose end when the fuse is being cut, and the end is pulled along to the mark indicating the length desired. Then with the fuse cutters the fuse is cut off at the other end, and another piece of fuse measured until all the fuses have been cut, the different pieces being left securely held between the nails until the miner is ready to cap them. To aid in the cutting, the fuse cutters, which are ordinary crimpers, are made with a spring rivited to one of the handles, so as to keep the jaws apart. This increases the speed of cutting the fuse somewhat, and the use of the crimpers more ent.

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One of the local dailies on th ing of the 10th printed an As Press resume of market condit New York which, among other mentioned: "The fresh advan accompanied by a fair consensus ful views of the business and f prospects FROM VARIOUS AU TIES, including THE REPUTED ER OF THE ORGANIZED M MOVEMENT TO ADVANCE PRICES THIS YEAR. * * approach of July settlements brings tightening money con PUBLIC WARNINGS have been BY GERMAN FINANCIAL AU TIES against undue extension o ing credits for speculation an DANGER OF COLLAPSE of a CONTINUED BOOM in industry. would seem to indicate that G at least, was about through buyi per. And it shows, also, that t PARENT strength of the market entirely due to the manipulations big interests which are determi unload on a gullible public.

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Mica prices vary with the size sheet. According to D. B. Ster the U. S. Geological Survey, it possible to give absolute prices o factured sheet mica from the dealers, since discounts allowe with the nature of the purchase prices of the sizes given in th below are quoted from a standa for 1911. Discounts ranging fron 10% are allowed on stove mica a 60 to 10% on electrical mica.

Prices per pound quoted for st electrical mica for 1911:

Stove Mica.		Electrical	
1½ by 2	$1.20	1 by 3	
2 by 2	2.00	1 by 6	
2 by 3	3.50	1½ by 4	
3 by 3	3.75	2 by 4	
3 by 4	7.00	2 by 7	
4 by 6	9.50	3 by 9	

CALIFORNIA GOLD DREDGING INDUSTRY

IN FOURTEEN YEARS THESE FIELDS HAVE CONTRIBUTED $48,000,000 TO NATION'S WEALTH

By AL. H. MARTIN.

Successful gold dredging in California dates from March 1, 1898, when W. P. Hammon and Thomas Couch placed a crude single-lift bucket-elevator dredge in commission at Oroville. The growth of the industry since then has been one of the rapid, important developments in world gold mining. In the brief span of fourteen years California dredges have produced in excess of $48,000,000, with the last three years particularly productive. Practically all of this has been contributed by the Oroville, American River and Yuba River fields, but recently important dredge activities have commenced in smaller districts, notably in Trinity, Calaveras, Siskiyou and Shasta. The California dredging field has been proven from Siskiyou, in the extreme northern part of the state, to Merced, a south-central county, and numerous previously neglected districts are promising to become important producers. Not only are new districts claiming interest, but some of the older sections also, due largely to the great reduction in operation and extraction costs attending the construction of the modern 15-cubic foot boats. The advent of these mammoths has enabled operators to profitably work deposits formerly considered valueless.

Aside from extension of the fields and construction of dredges of steadily increasing capacity, the greatest advance has been the reduction of working costs. In the earlier installations eight to ten cents per cubic yard of gravel handled was considered a good working rate, but with larger boats this was cut down to six cents. Subsequent installations steadily decreased expenses, until the new 15-cubic foot boats are easily handling gravel at an approximate cost of two cents per cubic yard, with even lower rates attained under particularly favorable conditions. From the 3-cubic foot dredge handling about 1,250 cubic yards daily, the capacity of the gold boats has increased to 15,000 cubic yards daily with the 15-cubic foot craft in action. The amount of yardage handled and costs established naturally varies under changing conditions, yet some of the best extraction and low-cost records have been made in fields noted for the deep deposits and difficult ground. This is indicated by the low costs and high yardage handled in the American River, or Folsom, field where much of the gravel is compact and difficult to handle, compared with the easily worked Oroville material. The building of large dredges appears in its infancy, and there are many California engineers who anticipate the construction of dredges exceeding 20 cubic yards before many years have passed.

The larger dredges naturally can only be profitably employed where the deposits are sufficiently extensive to justify the high initial cost. At present their use is confined to the three main fields, but an 11-cubic foot boat has been recently erected in Trinity county, near Lewiston, and similar large boats are planned for other outside districts. When the gravel is of limited extent the employment of a small dredge is virtually compelled, and operating costs are correspondingly higher. But the increased gold saving efficiency and generally cheaper power now obtainable in practically all districts have enabled operators to profitably handle small deposits formerly considered of scant merit.

YUBA RIVER LEADING FIELD.

The leading productive field is the Yuba River, located in Yuba county. This field is maintaining an annual gold output exceeding $3,300,000, with ten dredges in commission. Dredging in this field commenced in 1904, six years after the first boat went into action at Oroville. Two California type dredges, Yuba No. 1 and No. 2, were installed by W. P. Hammon and R. D. Evans in August, after an expenditure of nearly $100,000 in prospecting. This work continued two years, during which time about 300 test holes were drilled to depths ranging from 60 to 70 ft. The proven field has been developed for an approximate length of five miles and has an average width of one mile, but at times widening out to four miles.

During the extensive hydraulic mining operations prevailing in the early days of California, enormous quantities of tailings were washed down the Yuba river and its tributaries and deposited over the placer bed underlying the Yuba Basin. It is estimated that half a billion cubic yards of hydraulic tailings were deposited yearly, burying the river channel gravel to a depth of ten to 40 ft. Some gold exists, but not in sufficient quantity to justify working. The gravel rests on a bedrock of volcanic ash, strongly resembling the Oroville deposit, and ranges 40 to 90 ft. deep, with drill holes in some instances locating gravel and gold to a depth of 110 ft. below water level. The deposit yields ten to 30 cents per cubic yard throughout, and in dredging a portion of the soft, sticky bedrock is excavated. The natural water level ranges from several feet above to four feet below surface.

It was early seen that to work the Yuba River deposit satisfactorily large and powerful dredges must be provided. The two first boats installed were the first of their kind to excavate to a depth of 60 feet below water level, and several improvements were made to reinforce the digging apparatus and other equipment. In 1905 the Yuba Consolidated Gold Fields was organized to acquire the Hammon and Evans interests, and the rapid progress of the district virtually dates from this time. The new company was incorporated with $12,500,000, and immediately proceeded to install a number of California type dredges of the most powerful design. The later boats are excavating to a depth of 65 ft. below the water line, and one of the best low-grade records in California dredging was established by the 15-cubic foot boat of this company early in 1912, when gravel was handled at a cost below two cents per cubic yard. The holdings of the Yuba Consolidated Gold Fields embrace 3,000 acres. The Marysville Dredging Co. is operating on 600 acres of dredge lands adjoining the Yuba Cons. estate on the west.

OROVILLE AND TRIBUTARY DISTRICTS.

Oroville and its tributary districts, Wyman's Ravine, Honcut Creek and Butte Creek, ranks after the Yuba River field in production. Here was incepted the modern California dredging industry in 1898, and the particularly favorable natural conditions have materially aided in keeping the field to the front in subsequent years.

To date over $22,000,000 have been produced by the Oroville dredges, and although the major portion of the field has been dredged, a sufficient extent of

proven ground remains to insure activity for several future years. The bedrock is volcanic ash with the gold-bearing deposits ranging generally from 25 to 40 feet in depth. Most of the gravel is easily worked, and the numerous dredges in commission have experienced little trouble in handling the deposits.

In the outlying districts the gravel and formation closely resembles the main field, with the gravel clean, loose washed and dredged with comparative ease. Twenty-seven dredges are in commission in the Oroville field and its tributaries, ranging from small 4-cubic foot boats to the 15-cubic foot mammoth of Natomas Consolidated of California. Most of the dredges have capacities ranging from 5 to 7 cubic feet, the ease with which operations are conducted facilitating the profitable operation of the small boats.

In the early days of the field only the richest portions were worked, and several small tracts of good ground occur among the old dredged holdings. The gold-saving methods in the old days were far from efficient, and it is estimated that considerable sums were lost in this way. These factors have stimulated interest in plans to re-dredge the old workings, engineers believing the deposits still contain sufficient auriferous values to pay dredging with boats of the largest type. This may eventually result in the re-dredging of the major portions of the old field. The principal operating companies are Natomas Consolidated of California, Oroville Dredging, Limited, Pacific Gold Dredging Company, Oro Water, Light & Power Company, and two or three smaller concerns. The Butte Creek Cons. Gold Dredging Company is operating a 13-cubic foot dredge in the Butte Creek division of the field.

AMERICAN RIVER SUCCESSES.

Closely pressing the Oroville district for second honors as a gold producer, with the likelihood of winning the race before the close of 1912, the American River, sometimes designated the Folsom, district in Sacramento county claims particular attention. Operations in this district have had a commanding influence on the evolution of the California dredge, and its operators have demonstrated their ability to handle ground previously considered too refractory for dredging. Activities were incepted in the spring of 1899, one year after the first California dredge went into action, with the Colorado-Pacific Gold Dredging Company the pioneer. This was composed of Colorado people, with R. G. Hanford, manager. From the first it was apparent new and untried problems must be conquered before the great gravel deposits could be successfully mined. The field contains two distinct belts, one exceedingly refractory, the other easily worked by ordinary methods. The refractory belt is known as the Rebel Hill deposit, and the difficulties experienced in handling this gravel developed a new era in California dredging.

The Rebel Hill belt ranges from 50 to 75 ft. in depth, with the upper strata of six to eight feet partly ce
The succeeding 25 to 30 feet is
ingly compact, but below this th
is worked without difficulty. At
was considered impossible to
this deposit without continuou
ing, which besides materially in
costs, made work difficult and
factory. After repeated trials,
found best to undermine an
down the upper 20 to 30 feet by
ing hydraulic monitors, leavi
lower deposit readily accessibl
side the Rebel Hill belt the
have a general depth of 20 to

The Folsom Development Co.
undertook the construction of
No. 4 dredge, the pioneer of the
California type of gold-dredge.
departures from accepted types
order, and the entire craft w
structed along broadly progressiv
The boat was partly designed a
structed by the company in it
machine shops, with the Bucyr
chinery employed. The bucke
supported 68 13-cubic foot buck
the single-bank gold-saving tabl
replaced by a double-bank arran
The hull was massively constru
withstand the strain of the hea
chinery, and shaking screens i
to facilitate the handling of larg
tities of material. The boat w
along the original plans of Gener
ager R. G. Hanford, in face of
criticism of many prominent en
The first few weeks of operatio
followed with keen interest, an
it became apparent that the ne

**This Illustration Gives a Perfect Idea of the Manner in Which Dredging for Gold in California is Now Being Carr
The Left Page View Shows a Long Stretch of the American River Field Being Divested of Its Buried Wealth by One of th
Dredges of the Natomas Company; the Right Page Half of the Picture Shows the Tailing's Dump.**

was a brilliant success, it was realized that a new era in California dredge-building had arrived. The dredge handled approximately 250,000 cubic yards of gravel per month, and established an average working cost of three cents per cubic yard, a figure that stirred the interest of the most conservative.

Flushed with the success attending its venture, the Folsom Development Company arranged to conquer Rebel Hill. Accordingly Folsom No. 5 was constructed. This was the first gold-boat ever equipped with hydraulic monitors and was constructed along heavy lines to withstand the terrific strain it was evident must be considered. The buckets were of 9 cubic feet capacity, and two monitors, with three-inch nozzles, were mounted in the bow. A high head centrifugal pump, driven by two 50-horsepower motors, supplied water. This dredge went into action December, 1905, and immediately demonstrated its ability to handle the most refractory material. Considerable difficulty was experienced in handling the immense quantity of material and it was apparent that the washing facilities must be augmented.

The work of altering the equipment was turned over to the Western Engineering & Construction Company, and numerous improvements made. The shaking screens were replaced by others of the revolving type, and upper bank of gold-tables and a longitudinal sluice placed on both sides of the dredge, and a gold-saving contrivance placed in the save-all. Other work was done to lessen the strain and increase digging efficiency. Bucyrus machinery continued to be used. The reconstructed boat proved remarkably efficient and most of the subsequent installations in the Folsom field have been modelled along the lines developed by the experience with No. 5.

GIANT DREDGE CONSTRUCTION.

With the acquisition of the Folsom Development and other companies by Natomas Consolidated of California, January 1, 1909, the era of giant dredge construction dawned. This company, capitalized at $25,000,000, immediately proceeded to build several boats of the largest type, with the climax attained in the recently commissioned No. 10. This boat, like its predecessors, No. 8 and No. 9, are of the 15-cubic foot single-lift bucket elevator type, and was designed especially to dredge the Rebel Hill deposit. It is also the first all-steel dredge ever built in Califronia, the hulls of earlier boats being composed of wood. The bucket line consists of 90 15-cubic foot, close-connected buckets, and the dredge has a theoretical capacity of 450,000 cubic yards per month. The plate-girder digging ladder has a length of 119 feet and excavates to a depth of 55 feet. The buckets are built in three sections, securely riveted. The hood is composed of ½-inch steel plate, and the bottom of high-carbon steel reinforced under the back eye by an inserted plate of manganese steel. The lip is manganese steel, with a cutting edge 13 inches wide and two and one-half inches thick. Each bucket weighs about 3,700 pounds, and total weight of digging ladder, rollers, bucket line and auxiliary equipment exceeds 700,700 pounds. The tumblers are fashioned from high-carbon steel and cushion plates from chrome nickel steel. The 90 bucket-pins are made of high-carbon steel, oil tempered and annealed. Manganese steel composes the 184 bucket bushings. Digging ladder and bucket-line are operated by a 400-horsepower 2,000 volt variable speed motor.

The total weight of equipment exceeds 2320 tons, or a greater tonnage than many vessels. The steel hull displaces 920,000 pounds, a reduction of nearly 300,000 pounds from wooden hulls of identical type and dimensions. The saving of weight by the employment of steel reduces depth of hull from 12½ feet to 10½ feet, permitting operation in more shallow ponds. The dimensions of the hull are: length 150 feet, width 56 feet, exclusive of the overhanging five-foot decks on each side. The steel hull is expected to outlast about two ordinary wooden hulls, and it is understood initial costs closely approached the figures involved in wooden hull construction. Besides insuring long life for the dredge, the steel hull forms an excellent protection against fire, an element that has ended the career of a number of California gold-boats. Ten dredges are operating in this field, nine owned by Natomas Consolidated, and one by the Ashburton Mining Company. The present annual yield of this field is about $1,500,000.

TRINITY FIELD IN LIMELIGHT.

The latest field to claim particular attention has been developed in Trinity county, in the extreme northwestern portion of California. The placer depos-

its of this region have long been noted for their prolific wealth, and operations have been largely conducted by hydraulic methods. This county is exempt from the generally unfavorable California laws regulating hydraulic mining, as the streams are unnavigable, drain directly into the Pacific, and the adjoining lands are higher than the rivers. As a result hydraulic mining has flourished since the earliest days, and the county has long led all other California sections in this respect. However, in some instances hydraulic mining has not proven completely satisfactory, absence of sufficient water and topographical conditions militating against long seasons and the desired low costs. The result has been the adoption of dredge mining. Three dredges are active in this field, of which the largest is the 11 cubic foot boat of the Trinity Dredging Company.

Small dredges are operfating in Calaveras, Siskiyou, Shasta and other foothill counties, with the suction type claiming some attention in Shasta, where one or two boats of this type are working on the upper portion of the Sacramento river. Exclusive of some small suction and dipper dredges, which have not figured to much extent in actual production, the California gold fleet embraces a total of 63 dredges. Of these 51 are in the three main fields.

The outlook is distinctly favorable for an expansion of the dredging industry for several years to come, improved methods and lower working costs permitting the handling of low grade material in the old fields, while auriferous belts in the newer regions offer much promise. The onward march of the goldboats in the lower Sacramento valley has been to some extent checked by the agitation of sentimentalists, who hysterically clamoring the dredges were ruining good farming land beyond redemption, have fought the operators viciously. But the wise policy adopted by Natomas Consolidated and other far-sighted companies is steadily overcoming the prejudice that has so long prevailed. By removing the rock and reducing it to road and structural material the unsightly tailings are being eliminated and the planting of the cleared land has strikingly demonstrated the fertility of the soil.

At Oroville and other centers trees, crops and vineyards flourish on reclaimed land, and numerous acres formerly worthless for agriculture have been transformed into fertile tracts. The dredging industry has builded prosperous cities in the Sacramento valley, and introduced a new regime of progress and accomplishment in districts formerly smothering in their own infirmity and dry-rot. Factories have sprung up, and a flood of gold from the old placers has quickened prosperity throughout the State. The companies have co-operated with the Debris Commission and the State and Federal Governments in building barriers to hold the turbulent Sacramento river and its tributaries in leash during the flood seasons, and otherwise contributed to the upbuilding and advancement of their particular fields.

REINFORCED CONCRETE IN MINE SHAFT WORK

By E. R. JONES.*

This evening, as at another time, I find that I am acting in the capacity of lieutenant of Mr. Uren. Mr. Uren has already gone into the subject of concrete construction, generally, and in some detail, and it has been left to me to furnish some information on reinforced concrete as applied to shaft construction.

I wish to thank Mr. S. R. Smith of the Ahmeek Mining Company, and Mr. Will Smith of the Mohawk Mining Company, for information furnished me.

That which follows deals principally with the making and installation of concrete, and most of the information which I may be able to furnish you has been acquired through personal experience and intimate contact with the work.

Since the cost of material for the making of concrete varies widely with the locality and the property, and there is also a discrepancy in the wage scales of the different mining companies, any detail of costs would not only prove tiresome but would be of little value, except where conditions were exactly similar to those below described, so that, where cost is mentioned, it will be for the purpose of comparison in a special case with timber which the concrete has supplanted.

For a number of years solid concrete and reinforced concrete shaft collars and shafts have been in vogue where the conditions warranted a shaft of any degree of permanence, but not until nineteen hundred and nine was reinforced concrete tried as a substitu take the form and similar method installation as the long-used timber for shaft purposes; namely, at th 3 and 4 Shafts of the Ahmeek M Company.

In the beginning, two distinct of material were used; a good gra gravel and natural sand from a pit; and the trap rock, through the shafts were sinking, together clean conglomerate sand from the H Mill. Sets were moulded from two classes of material and ins with equal partiality and subse service has proven both to be equ the demands made upon them. set aside for the purpose were al to season sufficiently that they mig given a fair competitive test, and i found, on comparing the fractures two combinations of material, tha sand and cement filling the space tween the rounded pebbles broke from them, while the fracture in trap-conglomerate same combin continued through the larger ele of the mixture. The gravel mi could doubtless have been improved siderably by careful washing, but cost of preparation, compared wit trap rock and conglomerate sand, hibited its use in this particular ca

MATERIALS AND PROPORTIO

The materials finally used we follows:

No. 1. Portland cement. Cong rate sand. Trap rock trommeled ¾-inch through screens.

The proportions used were 1-3 wall plates, end plates, and divi and 1 2-4 in studdles. The rein ment in wall and end plates cons of three ¾-inch Monolith steel with ¼-inch webs, crimped onto together with two straight ¾-inch lith bars. The dividings were rein by four ½-inch Monolith steel wound spirally with ¼ inch steel the whole presenting a column square cross-section. Studdles we inforced with two pieces of old rope 1¼-inch in diameter. Rein concrete slabs were moulded for shaft lining, the material used fines of trap rock under ¾-inch, glomerate sand and Kahn exp metal as reinforcement. The mi used for slabs was 1 2-4. By wa experiment, the writer selected a of No. 1 hemlock plank of the length, width and thickness of a crete slab, which had seasoned fo year, supported them at either end placed them side by side, and applied an equal pressure across center of each. Three failure c appeared in the concrete slab previous to the breaking of the

* Read before the association of mining engineers of the copper country, the Michigan College of Mines Club at Houghton, Michigan.

lock plank, although total collapse of the concrete slab did not occur until the pressure was considerably increased. While the method of the test employed was crude, it proved to the satisfaction of the writer that the concrete slab was much superior in strength. Considering the rapid decay of timber used as shaft lining, no further comparison of the two is necessary.

In the moulding of the concrete sets, 2-inch No. 1 white pine was used in the construction of the forms. These were soaked in Delaney's wood preservative, and repainted with preservative on the interior each time before setting up, thus insuring them against warping and prolonging their lives indefinitely, as well as securing a smooth and easy parting from the concrete when removed. A Smith barrel type mixer was employed in preparing the charge for the forms. The amount of water used in the mix was such that, when the batch was piled, it settled rapidly without agitation. A dryer mix was attempted by way of experiment, but due to the amount of reinforcement employed, it was found impossible to ram the dryer mix into place.

The labor involved in the making consisted of two carpenters, setting up forms and keeping them in repair; one man wheeling forms onto skidways ready for filling, returning used forms to shop and cleaning the same; one man feeding mixer from stock piles of rock, sand and cement; one man delivering mix to forms and shoveling material into place; and one mason ramming charge into final position. With this combination of men as many as four complete sets, consisting of 64 separate pieces, have been moulded in one day of nine hours. In ordinary weather, the sides of the forms were allowed to remain in position over night, and then removed, while the bottoms were left in place another twenty-four hours. The bottoms were removed by turning the pieces on their sides, where they were left to harden one day longer before removal to the stock pile. All through the process of removal, the sets were handled with the greatest care in order to preserve the appearance of the set and prevent cracking, which might not develop to the eye until weathered. All skidways used in making and storing were brought to a level to prevent warping and bending while the sets were green, to insure a perfect fit underground, for unlike timber, the concrete set cannot be brought to place unless perfectly true. Sets should not have been used under sixty days after removing forms, although we, through the reduction of the stock piles, have been forced to install pieces of fourteen days set, but the greatest care was observed in handling and putting in place underground. Concrete sets one year old, which have been subjected to all manner of weather, can be abused somewhat and handled almost as carelessly as timber.

As before stated, the above mentioned sets were made for the No. 3 and 4 shafts of the Ahmeek Mining Company. The shafts are of the three compartment variety—two skidways and one manway, dipping at an angle of 80 degrees. The outside dimensions of the compartments are:

Shipways—7 feet 6 inches high; 6 feet 10 inches wide.

Manway—7 feet 6 inches high, 3 feet 0 inches wide, with the end plates and dividings, making the greatest span of 7 feet 6 inches. Offsets were moulded in all plates 5 inches from the inside face to accommodate lining slabs. Also, holes were cored for the use of hanging bolts and bracket bolts. The wall plates, end plates and studdles have a cross-section of 80 square inches—dividings 81 square inches. The percentages of reinforcement are approximately as follows:

Wall and end plates	5%
Dividings	5%
Studdles	3%

It was found advisable from the beginning, because of the great weight of the wall plates, to mould them in two sections, one section spanning the ladder way, and one skipway, and the other section spanning the remaining skip compartment. These two sections were connected when in place by two bolts passing through holes, cored for the purpose, and two straps of iron spanning the splice. Studdles were made for 4 feet 0 inches, 5 feet 0 inches, and 6 feet 0 inches sets to accommodate the ground passed through.

The weights of the different pieces comprising the set are as follows:

Long section of wall plate	1,035 lbs
Short section of wall plate	700 lbs
End plate	600 lbs.
Divider	645 lbs
3 feet 3-inch studdles	268 lbs.
Complete set of 16 pieces	8,104 lbs.

LINING THE SHAFT.

Taking the weight of No. 1 western fir, which has been exposed to the weather in stock piles, as 33 pounds per cubic foot, the above concrete set weighs almost three times that of a 12x 12-inch timber set which the concrete set is intended to replace. Because of this additional weight of the concrete set, it was found necessary to increase the usual five or six men on the timber gang to seven in number. In a vertical shaft, to which the concrete sets are especially adapted, the number of men per gang might again be reduced. The sets are hung or built as the ordinary timber sets, only requiring an additional rope and block to swing the pieces in place. After the sets are wedged to line, bottoms are put in between the plates and the surrounding shaft wall, and the set is then tied to the shaft wall by means of concrete, in the proportion of 1-3-5. The concrete slabs are then put in place, and loose rock thrown behind them, filling up what space still remains between the set and the wall of the shaft.

After the set is in place, it is extremely important that it be well protected from the blast, for, unlike the timber set, concrete will not stand the blast. For this purpose, the writer used flat timber and steel plates chained to the under side of the plates and dividings, and even this precaution was at times inadequate. Where the ground was breaking easily, the sets have been as near as twelve feet to the miners, and again, when the ground was especially refractory, sets forty feet from the blast have been cut out. It is obvious that it is well to keep as far behind the mining as the ground will permit. In dangerous ground, which required timbering close up to the sinking, timber sets were used, but, had not time played an important part in the sinking, no ground was met in which concrete sets could not have been installed. With a gang of seven men, one complete set can be installed in a nine-hour shift. This permits a sinking rate of better than one hundred feet per month, which was accomplished at the No. 3 and 4 shafts.

The comparative cost of the concrete set and timber set, delivered at the shaft collar, is striking. The concrete set was delivered for $22.50, the timber set for $37.60. These figures are based on:

Western fir @ $28.00 per M, f. o. f. car.
Crushed rock @ .35 per yard, f. o. b. shaft.
Conglomerate sand @ .60 per yard, f. o. b. shaft.
No. 1 Portland Cement @ 1.15 per bbl., f. o. b. works.
Reinforcement @ $12.00 per set, f. o. b. factory.

The Ahmeek Mining Company, I believe, was the first to adopt the concrete stringers, and the Mohawk Mining Company soon followed with their use. At the Ahmeek, these stringers have been in continuous use since the beginning of operations and have required no repairs. Supt. Smith of the Mohawk has informed me that soon after the stringers were installed, skip repairs increased about one hundred per cent.

The stringer being entirely rigid and the skip also of rigid construction, the axles of the skips were found to be crystallized and the rivets working loose. This feature was overcome by moulding 2-inch pine strips, after preserving them in Delaney's Wood Preservative to prevent decay, into the stringers at intervals of three feet, allowing them to project one half inch above the face of the stringer, and resting the rail thereon. The pine strips have been in place four years, and none have been replaced to date, and skip repairs have been reduced to normal. Possibly because of a differently constructed skip, Ahmeek repairs were not abnormally high but the same racking of the skip body occurred and the Ahmeek Company has adopted the Mohawk feature and expects to profit accordingly.

Concrete plats, or stations, have been in use at both the Ahmeek and the Mohawk for some time. They differ from the timber plat in outward design only in the cross-section of the members, which are 9x12 inches, and are reinforced with old rail and wire rope, and replace the 12x12 inch and 12x14 inch timber formerly used. Holes are cored to accommodate gates for skip and dump doors and tram rails are imbedded in the concrete, making the use of spikes unnecessary. When turn-tables are used on the back of the plat, the rigidness furnished by the concrete insures the trammers against derailed cars, resulting from a tilted table.

At the present time, our company is installing reinforced concrete dividings to replace the practice of putting in ten-inch flat timber. In cross-section they are 9x12 inches, and are reinforced by old rail. On the ladder road, they are placed six feet from center to center and between the skip compartments are put in as often as the hanging requires. Since the casing along the ladder road performs no other office than the protection of the men while on the ladder, or in case of a fall, plank is used for the purpose, and a 3 inch hemlock strip is moulded into the dividings to facilitate the fastening of this casing.

PAINSTAKING FOR GOOD WORK.

Quite often in the placing of concrete and reinforced concrete, both above and below ground, not enough attention is paid to the character of the men employed in charge of the mix and actual distribution of the material. It is not enough, that the work shall look finished and neat on the removal of the mould boards, which any gang of men can accomplish with only this end in view. The placing of concrete where strength is desired, as well as weight and finish, requires the greatest care and judgment. Men should be selected who will see that the fines are uniformly distributed with the coarser material, for, unless the rock of the mixture is made to well overlap, congregation of coarse material and fines will accumulate which will result in a weakness, which often cannot be detected after the work is completed. The ideal method of placing the mix is by hand with shovel, but in shaft work this method is slow and requires extra labor, where the work is situated some distance from the place of mixing. Where chutes are used to convey the mix to its destination, the larger material arrives in advance of the fines, making an even distribution difficult and at times impossible. The writer has eliminated this feature by placing traps at regular intervals in the conducting launders, for the purpose of retarding the larger particles, thus securing a more even mix at the end of the launders than at the beginning.

Concrete has long been used underground for bulkheads, forks, open gutters and casings for fire doors and cannot be surpassed for these purposes. As applied to shafts, the material is comparatively new, but each succeeding year marks its advance, and in the end, timber will have been entirely superseded. For much of the underground construction, timber is still the rival of concrete, but, due to the increasing scarcity of the timber suitable for mine use, it cannot long remain as such, and must soon make way for the more plentiful materials, concrete and steel.

PEN PICTURE OF NEW YORK

The New Yorker supposes the United States are so called because they are not separated from each other by the Hudson River. New York, although the metropolis of the western world, is located on a group of islands east of New Jersey. The archipelago is made up of Manhattan Island, Long Island, Staten Island, Governor's Island, Blackwell's Island, Bedloe's Island, the Emerald Isle, and Standard 'Ile. New York was discovered by persecuted Netherlands and named by the piratical English; it is owned by expatriated Americans, governed by evicted Irish, populated by wandering Jews and homeless Yankees. The resident of the metropolis is the original man without a country

The government of New York is hybrid, like its population. Its charter contains all the misfit paragraphs of the other thirty-three thousand charters of American cities. It is in some respects the most wonderful document ever produced by the hand of man (with the aid of scissors). It is fifty times as long as the United States Constitution and proportionately obscure. Its m tion is to enable the tail (Manh wag the dog. The supremac city hall is variously regard Island is stung by it, Staten stung less by Manhattan's mas by Jersey's mosquitoes, the Em is green with jealousy, Stan makes light of it, while Harlem has its goat.

The outlying parts of New inhabited by respectable but ho ple, who cling to terra firma ir Bronx cocktails and the Brookl Manhattan is the haunt of the ers, the submerged tenth, and ists, who are generally half-s Hence, the generous naughtyc ions, such as Raines Hotels, s theatres, the 'L roads, Jersey fa the Broad way which leadeth t twenty-six.

Ever since the city was fo moving "Vans," the population York has been restless and uns the pace of today beats th Three-fourths of the people are for work, the other fourth for neither group is happy when it This incessant activity results proof skyscrapers and marble inflammable tenements and i yellow journals, Fifth Avenue and femininity, and Bowery b booze, luxurious hotels and proli shops, high bridges, high prices, life, (also Metropolitan life and N life), the dead beat of Tammany antiquities of the Metropolitan the New Theatre and the new w newest railway stations and t scandal, an amorphous public lib an embryonic cathedral. In one may even find homes!

New York is unabashed by the above, the earth beneath, or th under the earth; its towers pi heavens, its subways the earth, tunnels the sea. Despite subw tunnels, subterranean restaura borough halls, the senior editor to heaven and the contributin giving them hell, life is chiefl surface. The streets are full breadth escapes, beauty is s books and milk are skimmed, a ness is on edge. New York may erficial but it is not unlettered true it is unacquainted with th ignorant of the meaning of D. scornful of T. R., but it hon I. O. U. of John D., and is rule O. K. of C. F. Murphy.—Twenti tury Magazine.

It is reported that the Homest ing Company of South Dakota encountered a considerable body grade free gold ore in its lowes

Edison's New Method Of Ore Separation

A few weeks ago the newspaper press of the country was flooded with accounts of a new process of extracting metals from ores by which Thomas A. Edison proposed to revolutionize the industry of mining and convert worthless masses of rock that might contain even infinitesimal quantities of gold, silver, lead, zinc or copper into bonanza mines. No one at all familiar with mining and milling paid serious attention to the flamboyant stuff thus paraded as "news," and which failed utterly in the presentation of descriptive detail realizing, in the first place, that a man like Edison—nor anyone with authority to speak for him—would father such "wild and wooly" publicity concerning any invention that might have as an object the simplification or improvement of methods now in vogue for the separation of mineral from the gangues or matrixes in which it may occur. The one prevailing impression that the articles referred to seemed to convey was that Mr. Edison had perfected a solvent of some mysterious character that would extract values from ores of very low grade with such ease and at such small cost that almost any kind of rock carrying mineral could be worked at a profit.

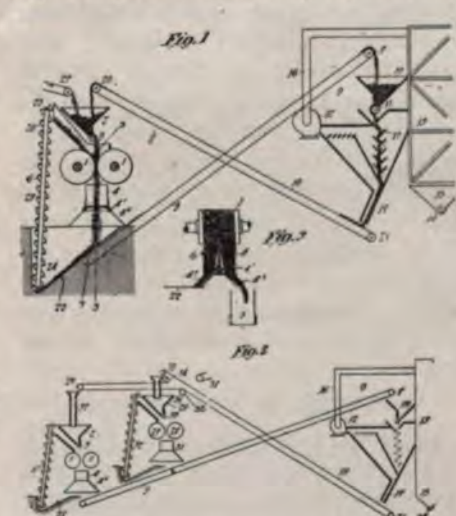
In a letter wherein he comments on what the newspapers have been saying, Mr. Henry B. Clifford, president of the Clifford Exploration Co., of New York, among other things, says:

> Over a year ago we interested Mr. Edison in the question of an improvement in concentration, utilizing his fine grinding rolls as the basis for the prevention of sliming. During the past year we have made considerable progress in making higher savings from the finer meshes, and also in the general separation of the metal in complex ores, dividing the lead, zinc, iron and copper by a system of concentration. These experiments have been conducted in a large 100-ton unit in his laboratory at Orange, but there is yet considerable to be done before we will feel justified in erecting a practical plant.
>
> Mr. Edison does not anticipate entering mining or milling, but by his arrangement with ourselves, if this improvement works to his satisfaction, we are to attempt to commercialize it by erecting a large plant somewhere in the west, that a thorough demonstration of its practicability can be made before offering the improvement to the mining public. Mr. Edison has made no claims whatever, as we are still experimenting on the problem.
>
> What I desire more to impress, is that he is not working upon a solvent; simply an improvement in concentration.

With this explanation by Mr. Clifford, it will be of interest to those who have been following the subject—and particularly the general reader—to learn just what Mr. Edison is attempting in the way of ore concentration. The following description of his latest patented ore-separating devices—granted March 12, 1912—was written by G. J. Rollandet and published in Mining Science, of Denver, on the 13th of the present month:

THE EDISON SEPARATORS.

The object of the invention here described is to increase the capacity of that class of appliances connected with crushing machinery, which comprises a crushing system and a blowing or other separating system whereby the fine ma-



terial sought, such as Portland cement, can be removed from the body of the pulp and the coarse returned to the crusher to be reground.

As an introduction to the description of his invention, Mr. Edison states that in a patent issued to him January 22, 1907, for apparatus for grinding and separating fine materials, a system is described in which the product from a plurality of rolls passes to one common belt conveyor system, whence it passes down through a number of blowers connected with dust chambers for settling the dust blown out; the tailings of the separator, that is the material from which the fine dust has been so separated, falling upon one common conveyor system to be returned to the several crushing rolls for regrinding. Where the material to be handled is very hard, the percentage of fines, that is of material sufficiently fine to be utilized as desired, is small for the amount of material handled, and it is very desirable to relieve the conveyor system of so large a non-effective bulk, and to increase the capacity of the blowers or other means which may be employed for separating out fine material. This result is attained in a very simple manner by connecting to each roll an elevator and an adjustable deflecting plate beneath the roll, whereby any desired portion of the ore, after passing through the rolls and which would in the system shown in the patent above referred to, go directly to the blowers, is deflected to the elevator and returned to the rolls locally and re-crushed, thus enriching the ore which is conveyed to the blowers.

In the following description of Mr. Edison's invention, reference is had to the cuts accompanying this article, in which Fig. 1 represents a diagrammatic view of the system embodying the invention, in which a single pair of rolls only is shown. Fig. 2 is a diagrammatic view showing the manner of carrying out the same method with a plurality of crushing rolls used in connection with a common conveyor system, and Fig. 3 is a sectional view taken on line 3 3 in Fig. 1, showing the deflecting plate below a pair of rolls.

Referring to Fig. 1 of the drawings, the crushing rolls 1 are provided with ore or other material to be crushed from the hopper 2, which is provided with a roller feed 3 for feeding the material to the rolls in a wide, thin stream. The material crushed falls from the rolls in a stream which may be intercepted by an adjustable deflecting gate or plate, which is indicated diagrammatically at 4. The deflecting plate 4 is shown in full lines as intercepting the stream of falling crushed material midway to divide it evenly in two parts. The plate is shown as pivoted at 4^1 and may be tilted transversely to the direction of rotation of the rolls to such a position as to divide the stream of material in some other proportion, such a position being shown in dotted lines. Stationary guide plates 4^2 are shown below the pivot 4^1 to guide the streams of ore divided by the plate 4 to the conveyor 5 and the inclined surface 22. The material so divided passes part to the endless, continuously operating conveyor belt 5 leading to the blowers, and part to the continuously operating elevator 6, which returns the same to the feed for the rolls. The gate 4 may be

adjusted to effect any desired ratio of division of the crushed material.

BLOWER SYSTEM OF SEPARATION.

As indicated, the conveyor 5, which rotates over wheels 7 and 8 at either end thereof, carries the ore to a separator 9. While any suitable form of separator may be used, it is preferred to employ a blower system, as shown, wherein the material falling from the conveyor 5 into a hopper 10 is fed by a roller feed 11 into the path of a current of air blown by a fan or blower 12. The air blown by blower 12, and carrying with it the fine, dust-like particles contained in the falling stream of ore, passes into a series of settling chambers 13 in which the dust settles and from which it may be removed by means of a conveyor 14 passing through the hopper 15 in the bottom of the chamber. The supply of air for blower 12 is drawn through a tube or passageway 16 from the dust chamber itself, so that a closed circulating system is thereby provided in which the ill effects of changes in the condition of the outside atmospheric air are prevented. The stream of ore falling from the roller feed 11 in the path of air proceeding from the blower 12 is intercepted and delayed in order that the air currents may properly separate the fine particles therefrom by means of baffle plates 17, as shown.

The tailings from the separator pass through a spout 18 on to a continuously operating conveyor 19 carried by rollers 20 and 21, which return the said tailings to the hopper 2 to be again passed through the rolls 1. The portion of the ore passing through the rolls 1, which is deflected by the gate 4 into the local system, passes down the inclined surface 22 from the bottom of which it is removed, as stated, by the continuously operating elevator 6 and fed into the feed for the rolls as above stated. The elevator 6 is shown as consisting of an endless belt 23 passing over rolls 24 and 25 and provided with buckets 26, atlhough any other form of conveyor by which the ore deflected might be continuously conveyed to the hopper of the crushing rolls might be employed as well as the form indicated.

In Fig. 2 of the drawings the same system is represented with the addition of a second pair of crushing rolls to indicate the manner of proceeding when a plurality of such rolls are used in the system. Here, as in the case of Fig. 1, the ore fed to rolls 1 by roller feed 3 is separated by deflecting gate 4 into two divisions, one of which is carried by conveyor 5 to separator 9, and the other of which is guided by inclined surface 22 to elevator 6 to be conveyed back again to the feed for the rolls 1.

Ore for the rolls 28 is fed from hopper 29 by means of roller feed 30 and is deflected in a similar manner to that described in connection with the first named pair of rolls by means of deflecting gate 31 into two divisions, one of which falls upon the conveyor 5 and the other of which is elevated by the elevator 32 to be added to the feed for the rolls 28. The tailings of the separator 9 fall from spout 18 upon conveyor 19, whence they are conveyed back to the feeds of the several crushing rolls as indicated in the figure. The conveyor 19 passes over the rolls 20 and 21 at the ends thereof as in the case of Fig. 1, but it also is guided by rolls 33, 34 and 35, so that a portion of the ore carried thereby may be fed into hopper 29 for rolls 28, while the remainder of the ore is carried to hopper 2 for the rolls 1. This is arranged by having the conveyor provided with rolls 33 and 34 so positioned as to conduct the conveyor 19 past the hopper 29 with an upper and a lower run, whereby the conveyor in passing over roller 33 unloads ore through chute 36 into hopper 29 to an extent equal to the capacity of the rolls 28, while the remainder of the ore carried by the conveyor 19 is caught by the lower run of the conveyor and carried onward to chute 37 of hopper 2. Crude ore from the stock house may be added to the system at any convenient point as by the conveyor 38 indicated diametrically in the figure.

HOW THE SCHEME WORKS.

As an example of the use of the invention, if it be supposed that 300 tons of ore pass through a pair of rolls per hour with 10 per cent of fine material of the required size therein, 300 tons would have to be handled by the conveying system and blowers per hour to obtain 30 tons of fine material in a system of the type indicated by the letters patent above referred to, and before the addition of the invention described herein. If, however, say 150 tons of the 300 tons crushed per hour by the crushing rolls in this illustration be removed by the deflecting gate, passed to the elevator and thence again crushed by the rolls, the latter would still be crushing 300 tons of ore per hour and the blower or separator would be separating nearly 30 tons of fine material per hour as may be demonstrated mathematically, but the conveying system and the blowers would be carrying only 150 tons per hour.

It should be noted that when the deflecting gate is set in its middle position, a given amount of uncrushed material is fed into the rolls in a given short time interval from the belt 19 and from the stock house, and an equal amou material partly crushed or fine partly uncrushed is fed into the from the continuously operating el system. A given percentage of t crushed portion of the materi crushed in passing through the and all the material is divided i one part going off on belt 5 blower and the other part bei turned to the rolls by elevator 6. portion must average the sam centage of fine material. The p of material, crushed or fine ar crushed or coarse, returned local the rolls, meets in the hopper an amount of material, all coarse, fro 19 and the stock house, and the tion of crushing and dividing is rep the same given percentage as bef the uncrushed part of the materi ing reduced to fineness in the p of the whole through the rolls.

It will be seen that in continuous ation the percentage of fines in th terial returned locally to the ro creases rapidly at the start an proaches a maximum, which in t ample given seems to be approxi 27.3 or not far from 30 tons of fin hour, an equal amount of fin course, being carried off by the to be blown. Therefore, if the ca of the conveyor system was 300 to hour, two sets of crushing rolls be used therewith in place of th set previously used, in which cas tons of material would go over th veying system per hour with a mately 55 tons of fine material re per hour by the blowers. In the illustrated in Fig. 2, for example, capacity of the conveyor 5 is con to be 300 tons per hour and the ca of the sets of rolls 1 and 28 to t tons per hour each, and the gates 31 to be so adjusted as to divid stream of ore falling from the r and 28 into equal parts, 150 ton hour would then be deflected b gates to the conveyor 5 from ea of rolls, and 150 tons per hour be deflected from each set of ro the elevators 6 and 32. With blower separating then approxi 55 tons of fine material per hou the conveyor 38 from the stock making up the deficiency thus sioned, the conveyors 5 and 19 wo operated up to their capacity of 30 per hour and 150 tons of ore per would be fed into each of the h 2 and 29 from the conveyor 19 an tons per hour into each of the sai pers from the elevators 6 an whereby each set of rolls woul supplied with sufficient material erate at its capacity of 300 tons hour.

PRESERVATION AND DECAY OF MINE TIMBERS

By G. B. McDONALD.*

The subjects of decay and seasoning of timber are more or less closely associated with the matter of preservative treatment. Decay in wood is an organic process caused by low forms of plant life, either bacteria or fungi. The bacteria are microscopic in size but the fungi become quite conspicuous when the fruiting bodies appear on the surface of the wood. The fungi consists of small threads which penetrate the wood structure and these are the real cause of decay rather than the fruiting bodies commonly known as punks or brackets. Under proper conditions the spores produced by the fungi gain access to the wood structure and decay soon begins. The spores of the rot producing fungi may gain access to the timber either before or after the timber has been felled. However, it is generally the case with mine timbers that the disease is contracted after the timber has been placed in the mine, due to its close proximity to other decaying timbers. A rough wood furnishes excellent place for the lodgment of spores and also good conditions for holding moisture, thus hastening the process of decay. Although timbers may have been sufficiently treated externally with some good preservative, yet the spores often gain access to the interior of the stick through season checks or cracks which are not thoroughly protected by the preservative fluid. It is frequently the case that a fungus is growing in the timber before the tree is felled. If the fungus is subsisting on live wood and is not able to survive on dead tissue, the felling of the timber causes the death of the fungus and avoids further decay from that source. If the fungus is developing in the heart wood of the tree, which is practically dead tissue, the rot may continue to develop after the tree has been cut down and worked up into mine timbers.

Wood is composed of small cells which are made of cellulose; around these cells is a substance known as lignin. Some species of fungi attack only the cellulose of the woods, others only the lignin around the cells, and still others disintegrate both lignin and cellulose causing a complete breaking down of the wood structure. After the wood is first attacked by a fungus, discoloration takes place and later the wood fibers are changed to such an extent as to make the wood soft, brittle, and practically worthless for any purpose. Any fungus must have for its proper development, a supply of moisture, heat, air and food. Without any one of these the fungi can not develop. In places where the timbers are constantly dry there is no danger of rot producing fungi doing damage. The conditions which hasten the rotting of timber are those where the wood is constantly subjected to alternate wetting and drying. A good circulation of air is also an important factor in preserving timber in a mine, in that it tends to reduce the amount of moisture present. Shafts where ventilation is poor, where there is an abundance of moisture and heat, are the most favorable for the development of fungus diseases. Although the loss of timbers can never be wholly prevented, yet the life of the timbers can be very materially increased through proper methods of seasoning and preservative treatment.

INCREASING LIFE OF WOOD.

For all classes of round timber, either posts, piles or mine props, it is thoroughly understood that the removal of the bark prevents decay to a certain extent. This is due to the fact that while the bark is on, the wood adjoining the inner bark is kept constantly moist and the conditions are ideal for the development of fungus. The peeling is effective inasmuch as it hastens the seasoning process. The cost of peeling is an item which must necessarily be considered, however, as we are told by the Forest Service that it costs only from twenty to fifty cents per ton to peel mine timbers. It is no doubt true that many times this amount is saved by the increased length of life of the timbers. The simplest means of materially increasing the life of wood is by proper seasoning. It is well known that the amount of moisture in any piece of green timber depends upon the part of the tree from which the timber has been cut. The outer zone of a tree, or the sap wood, contains a much greater amount of moisture than the heart-wood. On this account, and for the reason that the outer zone is more exposed to fungus spores, the sap wood is more subject to decay than the heart wood. On the other hand the sap wood portion of a tree will season more rapidly than the heart wood portion. By piling the timber in such a manner as to permit a free circulation of air, the seasoning process can be accomplished quite rapidly. However, the time required for the seasoning depends to a large extent on the climate. By kiln drying the moisture content of the timbers can be reduced to a smaller per cent than by the mere process of seasoning, however, this will add a considerable item of expense. It is well known that by reducing the moisture content the strength of the wood is materially increased, provided that an excessive amount of moisture is not driven off so that the wood structure is effected. A piece of timber well saturated with moisture is generally considered about one-half as strong as a properly seasoned stick.

Seasoning will prevent the work of rot producing fungi so long as the timber remains comparatively dry. When the timber is to remain in a moist situation, another method may be employed, that of poisoning the food supply of the fungi. This is brought about by injecting a poisonous fluid into the structure of the wood or by merely applying a coating of some antiseptic to the surface of the timber. A great variety of preservatives have been tried out in the United States and also in other countries; however, there are only four which need to receive serious attention. These are creosot, zinc chloride, corrosive sublimate and copper sulphate. At the present time in the United States the last two have been almost discontinued. There are a large number of patent preservatives for sale, all of which have as a basis either zinc chloride or creosote. Creosote as used for the preservation of timber is a bi-product of coke oven plants. Unlike zinc chloride, creosote is a very complex substance, being composed of a great number of compounds. Both zinc chloride and creosote are exceptionally good preservatives, yet creosote has the advantage in that it is not soluble in water; this fact making it superior for preservation of mine timbers, especially those subjected to moist situations. When once injected into the structure of the wood, creosote will not wash out. Zinc chloride is cheaper but timbers preserved with this fluid are only serviceable in comparatively dry situations.

METHODS OF PRESERVATION.

The methods of preservation of mine timbers may be covered under three heads: First, surface treatment; second, open tank treatment, and, third, high pressure treatment. The surface method has been used to some extent in the treatment of mine timbers. This method in its simplest form consists in applying a thin coating, preferably of hot preservative, to the timber by means of a paint brush. The objection to the method consists primarily in the

* In Iowa Engineer.

fact that it is difficult to get the preservative well into the season checks, knot holes, etc. The preservative in this case only penetrates a very thin zone; however, as long as this zone of preservative remains unbroken there is little danger of decay. In this method it is especially important that the timber be thoroughly air dried before the preservative is applied, otherwise the evaporation of the moisture from the interior of the stick will cause checks and expose some of the unprotected

Fungus Growth on Untreated Mine Timber. Third from Left Was Treated.

wood to the fungi. This method is often used where only a small amount of timber is to be treated, an amount which would not justify the installation of the apparatus required for the use of other methods. It is often the case that the brush method of treatment is a more expensive means of preserving the timbers than by dipping them in a tank. If the proper apparatus is available, it is a much simpler and quicker method to immerse the timber for a short time in the preservative. The dipping process is not only more economical of labor but by its use season checks, cracks, etc., are covered more satisfactorily than if the brush is used. The preservative will penetrate the surface of the wood better if it is warmed before immersing the timber. In some cases, the timber may be allowed to remain in the fluid for a few minutes before being removed; however, this method is entirely different from the one to be described under the heading of "open tank treatment."

In the Open Tank treatment the penetration is secured by an entirely different process. This method compares more nearly with the "high pressure" method than to the dipping or surface treatments just described. After the wood is thoroughly seasoned and a greater part of the moisture in the cells and cellular spaces is replaced by air, the timber is immersed in a hot bath of creosote or zinc chloride as the case may be. The hot bath is continued from five to six hours, depending upon the kind and condition of the timber. In the hot bath the air and moisture in the wood expands and a portion of them pass off. At the conclusion of the hot bath, as quickly as possible a change is made to a preservative having a low temperature. This causes a contraction of the air and moisture still remaining in the wood, thus creating a partial vacuum which draws the preservative into the wood. In this method, through atmospheric pressure, is accomplished the same results as with artificial pressure under the "high pressure process." Green timber is very unsatisfactory to treat by this method since it requires a much longer time to make the treatment and there is an unnecessary loss of preservatives through volatilization. The penetration of the wood may be secured by any one of the following schemes; first, after the timber has remained in the hot preservative for some time the heat may be withdrawn and the preservative allowed to cool without changing the timbers from the tank or without changing the preservative; second, the timbers may be transferred from the hot tank to another containing a cool preservative; third, after the heating process, the preservative may be drawn

Fungus Growth on Untreated Portion of Mine Timbers. Upper Portion of Timber Treated, Lower Portion Untreated.

off and replaced by a cool solution without removing the timbers.

OPERATING OUTFITS.

For a small operation a convenient outfit might consist of an old iron boiler ten feet in length placed vertically in the ground and set to a depth of about five feet. For a small job it would not be necessary to have the tank fitted up with steam coils for heating the preservative. It would only be necessary to construct a fire place beneath the tank and heat the preservative by direct heat. This outfit is very commonly used in the preservative treatment of fence posts. It is desirable to make the treatment as short as possible, not losing sight of the fact, however, that a certain amount of time is required to secure the object desired by this method, namely, a good penetration. The process is in reality a pressure process and differs radically from the mere dipping of the timber. The time necessary to secure the desired penetration will vary with the species and the moisture content of the timber and also with other factors. Many species of timber have a heartwood that is difficult to penetrate. With these it is generally useless to continue the treatment after the sap-wood or outer portion of the stick is thoroughly penetrated. The absorbing process takes place generally during the cooling of the liquid. It is not desirable in treating, to allow the temperature of the hot fluid to go above 215°-230° F., since the strength of the timber may be decreased. With most species of wood, especially those having a wide sap wood, a complete treatment of this outer portion of the wood will afford a good protection for the entire stick. The open tank method is not adapted to species which resist the penetration of the preservative fluid.

Under the High Pressure method, the two processes most commonly used are the "Bethel" and "Burnettizing." These processes are the same except that in the former cresote is the preservative used and in case of the latter zinc chloride. The method of injecting the preservative is practically the same in both cases. The timber to be treated is placed on iron trucks which are rolled into large horizontal iron cylinders, some of which are 8 or 9 feet in diameter and 150 feet in length. These cylinders are constructed so as to withstand high pressure and the doors fitted up so that they can be tightly sealed. After the cars of timber are placed in the cylinders, steam is admitted at a pressure of about 20 pounds to the square inch and this pressure is maintained for several hours. The steam is then blown off and vacuum pumps are started, which remove a large portion of the air and moisture from the wood structure. This process is continued several hours also, after which the preservative is run into the cylinder at a temperature of 160°, the pressure pumps are started and a pressure maintained until a sufficient quantity of the preservative is forced into the wood. The preservative is then drawn off and in a few minutes the timber is ready to be withdrawn.

SOME OTHER PROCESSES.

The "Boiling" process is very fre-

quently used for treating green timber. The equipment is practically the same as for the above processes except that the hot bath may be continued from a few hours to a couple of days, depending upon the size and condition of the timbers being treated. During this prolonged hot bath much of the sap and moisture of the wood is driven off by being forced out of the wood through expansion. After the hot oil is drawn back into the receiving tank, cooler oil is pumped in and put nuder a pressure of 100 to 125 pounds per square inch, thus causing a very good penetration in as much as the method takes advantage of high pressure along with a certain amount of penetration which is obtained due to the treatment with a colder liquid following a hot bath.

In the "Reuping" process the method is entirely different. The preliminary steaming is omitted. Before being placed in the cylinder, the timber is thoroughly air dried. Air is then pressed into the timber at a pressure of about 75 pounds until the wood structure is partly filled with compressed air, then, still keeping up this pressure, creosote is admitted into the cylinder at a somewhat stronger pressure. After the timber is entirely covered, the pressure is increased to 225 pounds per square inch, which causes a penetration of the oil into the wood structure. The creosote is then removed, thus relieving the pressure on the wood, which permits a part of the preservative to be pressed out of the wood by the compressed air within. This method has an advantage in using only a small amount of preservative.

Another method which is unique is the "Wellhouse." The preservative fluid which is used is zinc chloride. As we have said before, this preservative has the disadvantage of being leached out in moist situations. However, this process overcomes that difficulty. Before the zinc chloride solution is pressed into the timber, it is mixed with one-half per cent solution of glue. Later a tannin solution is forced in by a separate treatment. The effectiveness of this process depends upon the formation of a "leatheroid" substance in the cell openings which prevents the leaching out of the zinc chloride.

There are various other processes which may be described, each of which has its good points; however, most of them are quite similar to those already described.

In the treatment of mine timbers, a saving is not only afforded the consumer but the supply of timber is also conserved for the country in general. As the mere valuable species of timber become scarce, there is a constant tendency to substitute the inferior species of wood. This is being made possible by wood preservation which not only increases the length of life of the timber but also gives the consumer a much wider field to select from. Many woods which without treatment are almost worthless can be made serviceable by proper preservative treatment.

According to the Forest Service, the life of a mine prop has been estimated at approximately three years. It has been found that by treating, these props can be increased in length of life to thirteen years. From these figures it is easily seen how much of a saving may be effected through the use of preservative methods. As yet actual experiments in treating mine timbers have not been conducted with a large variety of species; however, there is an unquestionable saving for mine operators if they season their props before using and a great saving if in addition to that they treat the timbers with a preservative, preferably creosote.

LEA WATER FLOW RECORDER

In these days of scientific management, when so much depends on getting at the root of the evil in order to correct abuses, the Lea water-flow recorder is an aid in keeping an accurate record of happenings in the boiler room. It shows all irregularities in the boiler feed, records the quantity of water evaporated per pound of coal, and thus shows the number of heat units in the coal.

Lea Water Flow Recorder.

The apparatus works on the V notch weir principle and is described as follows: A float spindle passes through the bottom of the instrument case, gearing into a small pinion upon the axis of a drum revolving between centers. Upon the body of the drum is a screw thread, the contour of which is the curve of flow for the V-notch, in connection with which the recorder is used. The spiral drum thread rectifies the motion of the recording pen, so that it moves equal distances for equal increments in the rate of flow; it provides a magnified scale for making an accurate observation of the rate of flow at any moment.

The actual depth of water in the notch can always be observed, and the instantaneous rate of flow in pounds or gallons can be seen with a high degree of accuracy. The recording pen which moves in direct proportion to the rate of flow produces a diagram, the area of which is a measure of the total quantity, and this can easily be deduced by means of a standard planimeter.

Heretofore, the Lea recorder was made on the open or atmospheric principle, but recently the manufacturers added a new type. The notched tank is made of cast iron, similar to the standard open-heater construction. The tank is entirely closed and is suitable for withstanding any pressure or vacuum up to 10 lb. The operating head of the Lea recorder is only about 18 in. Hence it can be installed without extensive changes in piping. It is made in sizes from 200 to 10,000 boiler-horsepower.

Besides being used for the measurement of boiler-feed water, steam consumption, etc., the Lea recorder can also be used for measuring pump discharges, flow of streams, acids, etc. For measuring the flow of acids the apparatus is provided with wooden tanks lined with lead, and the V-notch plate is similarly made. Hard lead or glass, however, can be used.

The apparatus is guaranteed to produce records which shall be within 1½% of absolute accuracy by weight; also that the average error due to variations of temperature over a range of 50° F. (i.e., 25° F. on either side of the normal) shall not exceed 0.5%. A feature claimed for the Lea recorder is that it is equally accurate at large or small rates of flow. Moreover, accuracy can be checked at any moment by observing the head flowing over the V-notch and computing the flow by Thompson's formula, and then seeing whether the record on the chart is being made accurately.

The U. S. Steel Corporation is improving sanitary conditions at its Marquette Range mines by the installation of drinking fountains.

The mineral output of Rhodesia, 1911, was as follows: Gold, 628,521 ozs.; silver, 18,7641 ozs.; lead, 638.78 tons; chrome ore, 52,363 tons; coal, 212,529 tons; antimony, 13.75 tons; asbestos, 1,120 tons, diamonds, 6,889 carats; other gems, 90,070 carats; tungsten ore, two tons.

LAW OF THE PAY-STREAK IN KLONDIKE PLACERS

By J. B. TYRRELL.*

Twelve years ago I had the pleasure of reading a paper before this Institution** on "The Gold-bearing Alluvial Deposits of the Klondike District," in which the topographical features of the country were briefly outlined, and the general character of the gravels and the underlying rocks were indicated. At the same time it was pointed out that the two sources from which to obtain an adequate water supply for the efficient mining of Bonanza Creek were the Rocky Mountains to the north and the conservation of the water of the creek itself. It is interesting to record that both these projects, first laid before the public through ths Institution, have now been completed by the building of a great ditch and flume from the Twelve Mile River, at the foot of the Rocky Mountains, and by the building of a dam across the upper part of Bonanza Creek.

This evening it is my intention to present to you, very briefly, some of the results of a study of the placer deposits of that northern country, especially with regard to any light that they may throw on the laws governing the deposition of placers and the formation of the run of coarse gold which is usually found in the bottoms of the larger valleys, and which is known as the "pay-streak" or "pay-lead." It is believed that the laws or principles here enunciated not only explain the occurrence and characteristics of "pay-streaks" in the Klondike district, but that they have general application to the concentration of heavy metals or minerals in alluvial deposits.

Placer deposits may be defined as "detrital deposits of heavy metals or minerals mechanically concentrated by natural agencies."

Prof. James Geikie defines a placer as "an alluvial deposit derived from the disintegration of metalliferous rocks and orebodies of various origin."

Richard Beck says:

"By detrital deposits we understand accumulations of ore formed by the destruction and re-deposition of primary deposits. These two results have been accomplished, in the main, in a mechanical, but in part, also, in a chemical way. In both cases water was the main agent used by nature for the purpose. Such a destruction and re-deposition of primary deposits may have taken place in remote geoligic periods, but only in comparatively rare cases have the products of such periods been transmitted to us in a recognizable condition. On the other hand, the Tertiary and Pleistocene formations of the earth's surface contain a great number of such detrital deposits, as they are commonly called. It is customary to use the term placer gravels for the Pleistocene and Tertiary alluvial gravel depoisits."

And again:

"Placer gravels are deposits of loose, more or less rolled, material derived from the destruction of older deposits, lying on the earth's surface, or at least very close to it, and containing paying amounts of ore or precious stones.

"As the material composing placer gravels has been exposed to all the influences of the atmospheric air and of the water seeping through the upper stratas of the soil, placers will be found to contain, in the main, only relatively insoluble, and, in general refractory metallic compounds, which, moreover, are protected by their great specific gravity against easy removal by water.

"These placer gravels are usually grouped into two classes according to their position with reference to the deposit from which they are derived, and in part, also, according to the manner of the original process in which they are derived from the primary ore deposit:

1. Residual gravels, i. e., of local origin (eluvial gravels).
2. Alluvial gravels, i. e., formed by washing. These may again be subdivided, according to age, into recent, Pleistocene and Tertiary gravels.

"Residual gravels, the rarer of the two groups and certainly the less extensive, are found in the immediate vicinity of the original ore deposits, and quite independent of water-courses, viz., on mountain slopes, plateaus, and sometimes even on mountain summits.

"On the contrary, the gravels formed by the transporting and washing action of water are found only in the channels of brooks and rivers, in fresh-water lakes or along the sea-coast. They lie for the most part within the present valleys or along the present shore, but are also often found in stretches of fluviatile sediments, sometimes intersecting the present direction of the valley on old river terraces, or in sheets covering plateaus (California, Ohlapian in Transylvania), and, finally, in old shore terraces above the present level of the sea. Their material is always much rolled, and for the most part is assorted, according t size of the ingredients, into shingle vel, sand, clay, mud, etc."

Residual gravels occur on many higher slopes in the Klondike, but in few cases do they form wo placers. The best illustration of placers which came to my notice on the upper portion of Victoria one of the tributaries of Bonanza where some beautiful sharp " twins" of gold were found, just i condition in which they had been w out of a vein that outcropped high towards the summit of the ridge.

Most of the placers in the count such as are designated above "al gravels" and belong to the class o vial gravels found "in the chann brooks and rivers."

PAY STREAK ECCENTRICIT

In many of these alluvial gravel occur throughout the Klondike gold can be found, but in the grav posits in the bottoms of most of the valleys, whenever gold is present, not evenly distributed, for most c coarser particles are found in a ba restricted width which lies on or to bedrock, and wherever the be is fissured these particles descend i for varying distances. This band c of coarse gold is known as the streak," and the discovery of it be the gravel of the alluvial plain i constant desire of the prospector.

The existence of this pay-strea been recognized by placer miners time immemorial.

A. G. Locke refers to it as the ter," which he defines as the lowes tion of a lead, which contains the highly auriferous dirt."

Posepny states: "The gold occur centrated in the deepest portion weather-detritus, that is to say, o contact with bedrock, and has pene all the open, loosely-filled fissur the latter."

Beck states: "It would, howev an error to assume that in a cro tion of a river valley the lowest of shingle, gravel or sand are th out the richest. On the contrar values in this horizon are variabl pay gravel is ordinarily limit streaks of greater or less width, are found in one place in the cen the valley, in another along one now nearer, now further away, fro present water course."

W. Lindgren writes of the pay- as follows: "It is well known to al miners, however, that the gold i equally distributed on the bedrock channels. The richest part for streak of irregular width referred the English colonies as the 'run o and in the United States as the

* Paper read before the Institution of Mining and Metallurgy.
** Trans., viii, 217-229.

streak' or 'pay-lead.' This does not always occupy the deepest depression in the channel and sometimes winds irregularly from one side to the other. It often happens that the values rapidly diminish at the outside of the pay lead, but again the transition to poorer gravel may be very gradual. An exact explanation of the eccentricities of the pay-lead may be very difficult to furnish."

It is true that the pay-streak very often seems to be one of the most elusive of phenomena, and time and again the prospector is inclined to say that there has been no advance in the knowledge of the laws which govern the deposition of placer gold since the days of Job, 25 centuries ago, and that all that can be said now, as then, is that "There is a vein for silver and a place for gold."

But the pay streak is a feature in the structure and growth of the valley in which it occurs, its formation is governed by certain geological laws, and those laws should be recognizable without great difficulty if the growth of the valley can be traced with reasonable accuracy.

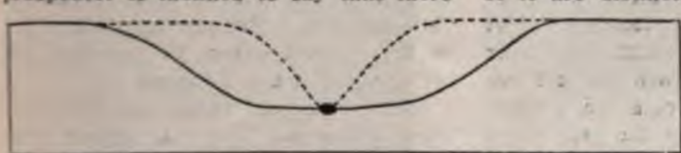


FIG. 1.—Diagrammatic representation of Pay-streak in the bottom of a simple valley.

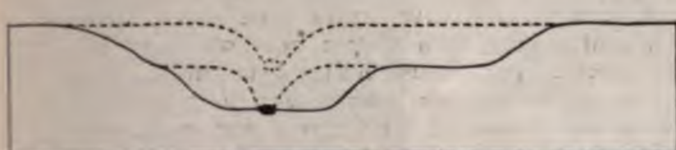


FIG. 2.—Diagrammatic representation of second Pay-streak directly below the first.

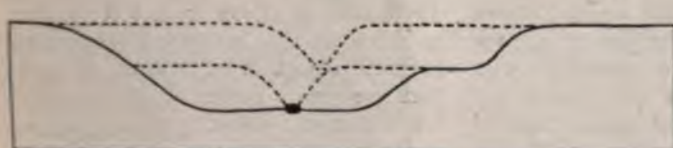


FIG. 3.—Diagrammatic representation of second Pay-streak obliquely below the first.

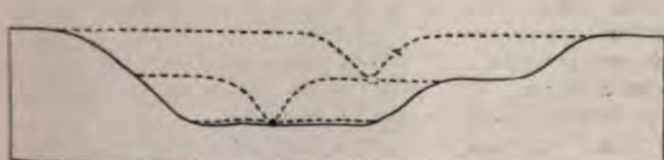


FIG. 4.—Diagram showing how first Pay-streak may be distributed in second valley.

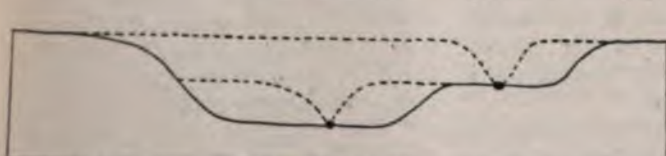


FIG. 5.—Diagram showing first Pay-streak as terrace and second lighter Pay-streak in second valley.

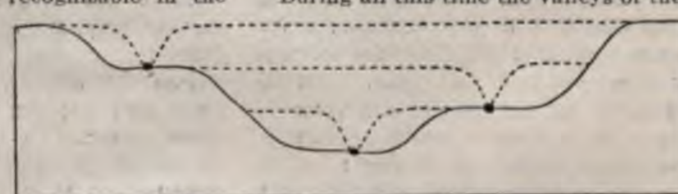


FIG. 6.—Diagram showing three Pay-streaks at different elevations.


FIG. 7.—Diagram showing formation and downward growth of a Pay-streak in a wide valley.

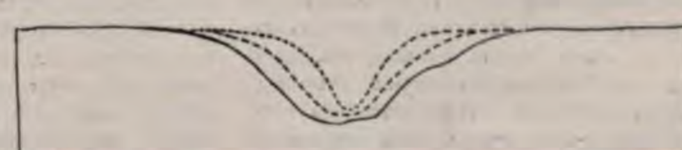


FIG. 8.—Diagram illustrating the transformation of a V-shaped valley into a U-shaped valley. (After Chamberlin and Salisbury.)


FIG. 9.—Diagram to illustrate the widening of a valley flat by erosion. (After Chamberlin and Salisbury.)

In what we now know as the Klondike district, marine sediments were laid down at various periods up to the beginning of Tertiary times, and after their deposition they were raised, crushed and bent into their present form and position.

The country was then worn down to base level, and a peneplain, the remains of which can now be seen at an elevation of about 3,300 feet above the sea, was formed. This peneplain may be called the "dome peneplain," as portions of it are distinctly recognizable in the vicinity of the mountain known as "The Dome." For our purpose the period of its formation may be designated as the "first cycle of erosion," since the history of the gold-bearing gravels would appear to begin with it and no gravel deposits have yet been recognized on it.

After the dome peneplain was formed the "first period of elevation" began, and the country was raised to a considerable height above the sea. The Yukon river which had probably been outlined at an earlier period, immediately began to erode its channel, while the water, which fell as rain on the elevated Klondike land, carved out smaller valleys to carry the drainage from it to the larger river. As the Yukon river was a powerful eroding agent it deepened its valley rapidly, and at the same time the smaller streams radiating from The Dome, such as Bonanza, Hunker, Dominion, Sulphur Creeks, etc., kept excavating their channels to keep pace with the lowering of the bottom of the valley of the Yukon river, which was the master-stream into which they flowed.

During all this time the valleys of these smaller streams maintained the general character of gulches or young valleys, with V-shaped cross sections. But little gravel or loose material remained on the rock which formed the bottoms of their channels, for it was being constantly moved downward by the current towards the Yukon river, and, on the way, was helping to cut deeper and deeper into the rock over which it traveled.

While this process of deepening the valleys was in progress, detrital material was being constantly brought into them by wash from their sides and by smaller

streams from the ridges between them, and, as the rocks from whch this material was derived were gold-bearing, the detritus contained a small quantity of gold. Thus gold and particles or masses of rock were fed gently into the main streams.

Now, a stream with a certain velocity is able to carry pebbles of a certain size and specific gravity. If the specific gravity is constant the diameter of the pebbles which it can carry will vary according to the square of the velocity, and if the velocity remains constant, the size of the pebbles will vary according to the specific weight of the substance composing them weighed in water. For instance, if the velocity of a stream is doubled it is able to carry pebbles of quartz four times the diameter, or 64 times the weight, of those which it could carry before. If, on the other hand, one pebble is of quartz and the other is of gold, which is 11 times as heavy as quartz weighed in water, the volume of a pebble of quartz which can be carried by the current will be 121 times (11.2) as great as that of a pebble of gold, or, in other words, the diameter of the pebble of quartz will be about five times the diameter of the pebble of gold.

Again, if particles of quartz and gold of equal size are dropped into water the gold will sink to the bottom with more than three times the velocity of the quartz.

FORMATION OF PAY-STREAKS.

Where the fragments of rock, consisting of quartz, schist, granite, etc., and gold, are fed into the stream, they are caught by it and carried along the bottom until they lodge in some crevice or opening, from which they cannot be dislodged except by upward currents, and these upward currents will lift any pebbles of quartz or similar rock which are less than five times the diameter of nuggets, or grains of gold occurring with them, before they will lift the gold, even if the quartz and gold are equally accessible. This makes the removal of the gold exceedingly difficult as long as the crevice remains, for the upward currents will constantly carry away the finer and lighter rock, and undermine the grains of gold and allow them to sink. When the finer and lighter material is carried away, the coarser and lighter pebbles are exposed to the force of the current, and the smaller and heavier grains of gold are able to obtain lodgment beneath and between them so as to be almost inaccessible. In fact, under normal conditions, the spaces between the lighter pebbles are large enough to hold any grains of gold which could be carried by the current flowing over them.

It is thus shown that gold will remain permanently in a fissure of the rock in the bottom of a stream as long as that fissure remains in existence, and also that it will remain between or beneath larger pebbles and boulders as long as these remain unmoved.

Now, the small streams of the first period of elevation, which developed into, or was succeeded by, the second cycle of erosion, continued to cut down their channels as long as the Yukon River continued to deepen its valley. During all this the bottoms of their valleys continued to act as sluices, which were more or less efficient agents in collecting and retaining gold according to the character of rock of which they were formed. If the rock where the gold was discharged into the stream was a fissile schist standing on edge the gold would be caught at once, while, if it was a massive granite or other similar rock, without joints or fissures, or a smooth horizontal schist, the gold would be carried down-stream over it until it would be caught by some more favorable rock. In this way there would be rich places, and blanks in the streak of gold deposited in the bottom of the valley.

As the stream would continue to deepen its valley very gradually, almost imperceptibly, by downward erosion, those places which were underlain by schists standing in a vertical or highly inclined attitude would continue to hold the gold which they had already caught, and to accumulate more, for fissures would open as fast as the surface was worn away, and the gold would sink into them as they opened. On the other hand, those places which were underlain by a harder bedrock, and which had probably also a steeper grade, would remain barren. If, again, the character of the bedrock should change from "open" to 'tight," the gold which it had held might be undermined by the continual downward erosion, and so be brought again within the influence of the transporting power of the running water, by which it would be carried along to find some new resting place farther down the stream.

When the Yukon River had eroded its valley down to base-level, the smaller inflowing streams were no longer obliged to continue to deepen their respective valleys to keep pace with it, but were able to cut them down to grade, and then to widen and form flood plains in them, thus changing the V-shaped valleys into U-shaped ones, floored by alluvial plains through which the rivers and brooks meandered from side to side.

FLOOD OR ALLUVIAL PLAINS.

A normal stream decreases in velocity and gradient as it descends its valley and reaches grade near its mouth before it has cut down the rest of its valley to grade. So, when each of these streams had cut down the lower portion of its valley to correspond with the base-level established by the Yukon River, it would begin to meander and extend the width of its floor. At the same time, with the decrease in gradient the velocity of the current would decrease, and its transporting power would be diminished. Consequently, part of the detrital material which would be brought down by the upper and swifter portion of the stream would be dropped where the current was retarded by the decreased gradient, and would lodge in the bottom of the valley and form a "flood plain" or "alluvial plain." This alluvial plain would be first formed where the V-shaped valley changed into a U-shaped one.

Most of the gold which had previously been discharged into the stream with the detritus from the adjoining hills and ridges would have already lodged in the bottom of the V shaped valley, and would have settled down almost vertically as the bottom was lowered by the downward erosion of the stream. If any gold was carried down to the mouth of the V it would have a very strong tendency to settle just where the velocity of the current was diminished, or at the head of the flood plain, and the weaker current would have no power to pick it up again, or to release that gold which was already present beneath it on account of having been previously caught in the bottom of the V-shaped valley. Thus the pay-streak would be formed. Afterwards the gravel, sand, and alluvium of the flood plain would be deposited over and beyond it, but it would continue to mark the position of the bottom of the old V-shaped valley, no matter how wide the bottom of the mature valley might afterwards be extended.

After a flood plain had been formed at the mouth of a valley the river farther up stream would still continue the downward erosion of its channel until it reached the grade of that below it, when lateral plantation and the formation of the flood plain would begin. Thus the plain was formed gradually up the valley from its mouth, and always, where the old V-shaped valley changed into a U shaped valley, there was left a trail of gold beneath it.

The gold which was collected and stored in the bottom of the V-shaped valley had been derived from the rocks of the adjoining country. At the same time the lighter material derived from the disintegration of these rocks had been carried through the valley and out beyond its limits, for the stream was then cutting down and enlarging it, and not filling it up, and there was very little room beside the stream for the accommodation of loose rock material. At the head of the flood plain this gold, which had been concentrated from the rocks of

the surrounding country through previous ages, was gradually covered, and hemmed in on both sides, by gravel and alluvial material brought down by the stream at a later date. Therefore the gold in the pay streak was derived from its home in rocks at a date which preceded that of the formation and deposition of the gravel which overlies and surrounds it.

The gravel of the flood plain may itself contain some gold which had been washed down the stream with it, or which had been washed into the valley from the sides, but this gold is usually very fine, such as might be carried readily by the stream for long distances.

If, after the flood plain was once formed, the stream should continue to deposit gravel to considerable thickness in the bottom of the valley through which it meanders, the source of supply for the gold would, on account of the general wearing down of the country, become more and more remote, and the average gold contents of the gravel would gradually decrease from below upwards.

The laws governing the formation and position of the pay-streak in an alluvial plain in the bottom of a valley may therefore be stated as follows:

1. It was formed in the bottom and at the mouth of the V shaped valley, which was the young representative of the present valley.

2. It marks the position formerly occupied by the bottom of that V-shaped valley.

3. The gold contained in it was washed out of the surrounding country and collected into approximately its present position before the gravel of the flood plain (or terrace) was deposited over and around it.

It has been assumed, for purposes of illustration, that the growth of the valleys in the Klondike district, which empty into the Yukon River, was continuous and regular throughout the second cycle of erosion, and in view of their symmetrical character, and the regularity of the pay-streak, which has been shown to have existed in them, it is probable that this assumption is not very far from correct; but nevertheless there were doubtless interruptions and cessations, both in the regular course of erosion and sedimentation.

After the Yukon river had cut its valley down to base level in this White Channel period, or second cycle of erosion, the tributary streams flowing from the Klondike district also widened their valleys and formed flood plains, as has just been described.

Then there was a long period of

GROWTH AND CHANGE OF VALLEYS

quiescence, during which the base-level of the country was raised, permitting heavy accumulation of gravel in the valleys, while at the same time the hills and ridges were worn down to mature forms. At the mouth of the valley of Bonanza Creek the local gravels, derived from the watershed of the creek itself, accumulated to a thickness of more than 200 feet. These gravels can still be recognized forming terraces at many places on the hills several hundred feet above the bottom of the valley, and Mr. McConnel, who has carefully measured them, has shown on a map accompanying his report a pay-streak running in a very straight line through and beneath them. According to the laws here formulated, this pay-streak was formed in the bottom of the old V-shaped valley, which represented the valley of Bonanza Creek at the White Channel period in its youthful stages, and it now tells us the original position of the bottom of that V-shaped valley.

Just before, or at the termination of, the second cycle of erosion, the Klondike River brought a heavy load of sediment down from the mountains to the east, and covered the bottom of its own valley, and the mouths of its tributary valleys, with a bed of gravel, which, opposite the mouth of Bonanza Creek, has a thickness of 150 feet. The influx of this gravel caused the lower portion of the latter stream to move westward, almost to the limit of its own flood plain, and to be ready to begin a new rock valley with the advent of the next erosion cycle.

After the deposition of this upper gravel in the valley of the Klondike River a period of elevation set in and the third cycle of erosion was inaugurated, which has continued down to the present time.

With the advent of this cycle of erosion the Yukon River was rejuvenated and again began to actively deepen its channel, and at the same time the tributary streams also began to deepen their old channels, or to cut out new ones, in order to keep pace with the master-stream. The Klondike River, the largest affluent of the Yukon in this district, probably did not lag very far behind it in the work of downward erosion, but its tributaries, such as Bonanza and Hunker Creeks, undoubtedly continued to flow in narrow, V-shaped valleys as long as the main stream was actively engaged in deepening its channel.

Opposite the mouth of Indian River the Yukon River has not deepened its channel as far below the level of the channel of the second cycle of erosion as it has at the mouth of the Klondike River, and the Indian River itself, being a smaller stream, has not cut back its valley as fast as the Klondike River, so that Dominion, Gold Run, Sulphur, and the other tributaries of Indian River, have not had the same opportunity to deepen their channels as the tributaries of the Klondike River.

During the third cylce of erosion the smaller streams, and especially those flowing into the Klondike River, have cut down their channels to grade in narrow valleys, and have widened the bottom of those valleys by lateral planation and the formation of flood plains, giving them a U-shaped profile. Terraces have been formed on the sides of the valleys, indicating halts in the progress of downward erosion, and narrow V-shaped gulches still carry small, or intermittent, streams into the sides of the main valleys.

Pay-streaks, which have now been almost entirely mined out, ran beneath the flood plains down the bottoms of these valleys, or crossed the terraces on their sides, and other pay streaks were in process of formation in the gulches until that process was arrested by the work of the miner.

ECCENTRICITIES OF PAY-STREAKS.

It is not necessary for our present purpose to follow the growth of these younger valleys in detail, or to trace the formation of the pay-streak in them, for that was clearly governed by the laws which we have already enunciated, but it will be interesting to indicate a few of the eccentricities which may have been introduced in the pay-streak by irregularities in the growth of the valleys in which they were formed.

We have already seen that difference in the character of the bed-rock will produce a marked difference in the quantity of the gold in the pay-streak.

A variation in the supply will also influence the richness of the deposit, as may be clearly seen in many of the small lateral streams which flow into the main creeks. Some of these cut across the old pay-streak of the second cycle erosion, and where this occurs the gravels in the bottoms of these streams is enormously enriched.

Temporary cessation of downward erosion, with the corresponding formation of flood plains at successive levels, would appear, however, to exert the most powerful influence in affecting the nature of the pay-streak and introducing irregularities into it.

Let us suppose that a valley has been eroded down to the first level, and that a flood plain has been formed at that level. The pay-streak will occupy its normal position in this flood plain on the line of the bottom of the old V-shaped valley, as shrown in Fig. 1.

If the stream is rejuvenated and again begins to deepen its valley a number of other conditions may occur.

1st. It may cut down its channel di-

rectly beneath Pay-streak No. 1, in which the pay-streak will simply be lowered, and will contain practically all the gold from the older pay-streak, as well as any gold that may have been collected into the channel since the time of its formation, as shown on Fig. 2.

2nd. It may cut down its channel to one side of Pay-streak No. 1, and while still actively engaged in downward erosion may undercut the pay streak, and allow the gold to slide down the side of the valley into the stream, where it will be carried downwards until it finds a new resting-place. In this case, too, the second pay-streak will contain most of the gold that was in the first, but it will have undergone a decided movement down the stream. See Fig. 3.

3rd. The stream may cut out its second V-shaped valley entirely to one side of the first pay-streak, but when it again begins the process of lateral planation, and forms its second flood plain, it may undercut the pay streak, where part of it may quickly sink and form a pocket off the line of the true second pay-streak altogether (though it will give an indication of the former position of the first pay-streak) while part of it may be carried down by the stream and distributed in its winding channel. The true second pay-streak itself will, in this case, probably be very weak. See Fig. 4.

4th. The second channel may be formed altogether to one side of the first pay-streak, in which case the first pay-streak will be on a terrace and the second pay-streak will probably be weak. See Fig. 5.

Any of these conditions may occur in different parts of the same valley, and their relative intensity, or rapid changes from one to another, may cause great variations in the character of the pay-streak.

A greater number of stages in the deepening of a valley would allow for a still greater complexity in the character of the one or more pay-streaks which might be found in it, and these might be still further added to by a filling of the valley with detritus and partial re-excavation at one or more different times. But, for the period in which it was formed, the pay-streak represents the bottom of the young V-shaped valley, which formerly occupied part of the present valley.

MINE ACCIDENT WORK

The work transferred from the United States geological Survey to the Bureau of Mines related almost entirely to the mining and utilization of coal and the accidents connected therewith. The appropriation given to the Bureau of Mines for its work during the first year following its establishment were so worded as to be necessarily applicable to coal mining inquiries. Therefore it has not been possible as yet to extend the investigations of the bureau witn a view to their aiding in the upbuilding of the metal-mining industries. Meanwhile, however, the ratio of accidents to the number of men employed has been in many cases as large or larger in the metal mines of the country than it has been in many of the coal mines. The need for the extension of the mine-accident work into the metal mining field is a serious one.

However, the loss of life in connection with metallurgical operations in different parts of the country is worthy of serious consideration. A limited inquiry indicated that eleven deaths have been caused from posionous gases at a single metallurgical plant during one year. The serious need of inquires and investigations looking to the improvement of such conditions has become more and more apparent as inquiries have been made in connection with a number of the larger plants.

Furthermore, during the past several years the mining industries, in the Western States have fallen far short of the agricultural development. In some of the States there has been a retreat rather than an advance in mining development. It is believed that thorough inquiries and investigations concerning the metal-mining conditions in the Western States would do much toward improving the safety and health conditions, as well as toward generally advancing and upbuilding these industries. —From forthcoming annual report of United States Bureau of Mines, for the fiscal year ending June 30, 1911.

ELECTRICITY AND ITS DANGERS

The United States Bureau of Mines has just issued Technical Paper No. 19, written by H. H. Clark, the bureau's electrical engineer, on the subject: "The Factor of Safety in Mine Electrical Installation." The author acknowledges the many advantages that are known to attend the use of electrical machinery in mines, but urges that the requirements of safety as well as those of efficiency be considered when installing electrical mining equipment.

The paper calls attention to the fact that wherever the service conditons are indeterminate or variable, engineers are accustomed to use factors of safety in their designs, especially in those cases where the protection of human life is a consideration. The author believes that a similar factor of safety should be used in connection with the electrical equipment of mines.

To quote from the paper: "The safe operation of electrical mining equipment is an engineering problem that involves the element of human life and that is influenced by conditions and events that can not always be foreseen. The successful solution of the problem will, therefore, depend largely upon the factor of safety that is considered in the selection, installation, and maintenance of such equipment."

The paper proceeds to classify the electrical accidents that may occur in mines and states the principal sources of danger incident to the use of electricity underground. The conditions surrounding electrical equipment in mines are compared to similar conditions above ground and the paper shows that the requirements of mining work present certain difficulties in the way of maintaining electrical apparatus in perfect condition. The effect of roof falls, dampness, dust, and acid water are mentioned, and the observation is made that the temporary character of underground work limits the economical investment in electrical equipment and its installation.

The author does not regard the safeguarding of mine electrical equipment as a simple problem and states that there is no general formula for its solution. It is suggested, however, that a logical first step would be to remove contributory causes by placing lights and erecting guards at particularly dangerous points, and by selecting apparatus especially designed to offset the effect of dampness and dust.

A concrete view of the problem is presented as follows: "The problem of safeguarding may be divested of some of its vagueness and put in concrete form by considering that if the electric current can be kept where it belongs—in the conductors designed to carry it—it can not give shocks, set fires, or ignite gas, dust, or explosives. Electricity becomes actively dangerous only when it breaks away from its proper channels in stray currents or as sparks and arcs."

The paper lays stress upon the importance of first-class installation at the outset and frequent inspection of equipment after it is in place. The author considers that a competent electrician is needed to insure the safest and most efficient operation of mine electrical equipment and dwells upon the responsibilities and requirements of such a position.

Saturation is important but difficult to determine in any oilfield. Some lands yield 2000 to 3000 bbl. per acre and others as much as 100,000 bbl. At times, as one operator phrases it, "more oil comes out of a well than there is space in the rock below." Such anomalies are probably to be explained on the basis of fractures tributary to the well.

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CONTENTS:

Last month it was suggested that the Utah Copper management issue a statement this month showing how much new ore had been blocked out during the first half of the year, rather than wait until next spring and then tell us that another 100,000,000 tons had been added to the reserves. Our suggestion has been ignored, so the bankers and brokers who are still holding the sack may not be made to feel the effects of their folly by witnessing the addition of another $100 or more a share being developed in the mine and the stock going down as a result of the report, for some time to come. The announcement of an "extra" dividend may be the means of turning the trick the next time.

"REMODELING" MANIA OF UTAH COPPER

During the month of June one of the "remodeled" sections of the Arthur mill of the Utah Copper Company was closed down for ten days so that it might undergo another "remodeling." That the entire plant would have to undergo an additional "remodeling" sooner or later has been evident to everybody familiar with the record being made, but it was not expected that the second "remodeling" of the mill would begin until all of the thirteen sections had been brought up(?) to the standard of the company's famous Magna works, where they seem to have no great amount of trouble in saving just about as much copper as they lose. Wonder if they are going to give the "big drum" a try-out at the Arthur?

It is almost impossible to be serious when dealing with the subject of the Utah Copper's mining and milling practices, so broadly comical nave they become in the eyes of the mining and metallurgical profession everywhere. But it seems pertinent just now to call attention to the fact that this "remodeling" business has developed into what might justly be termed a perfect mania on the part of the engineers who have been shaping the destinies of Utah Copper, Ray Consolidated and Chino for the past several years without a protest on the part of those who now appear to be in urgent need of a Moses of some kind.

The Magna mill had barely gone through the smoothing-out stage of its career when its "remodeling" was undertaken. Equipment was discarded as being not the thing; other devices were tried and then some of the previously discarded traps were reinstalled; and so it has been going year in and year out, and this is the plant after which the Arthur mill, the Ray Consolidated and the Chino have been paterned, together with such modifications as were from time to time developed by the parent mill. The tinkering going at the Arthur is not to be wondered at, for the Ray Consolidated mill had only three units in commission when the "remodeling" of the first one was undertaken in order to keep pace with the head institution and, while detailed information concerning what is doing down there now is hard to get, there is no reason to believe other than that "remodeling" is still in progress, in order to catch up to what is now being done at the Arthur—and what is true of conditions at the Ray is most likely the case at the Chino, as well.

And it may as well be stated now that what is true of the mills also applies to the handling of the mines. There has been a system of "remodeling" or something of the kind constantly going on at the Utah Copper mine and if anything has been accomplished by it other than to hasten the "day of reckoning," there is nothing in the reports of the company to indicate it. The Utah Copper mine is now generally referred to by engineers and laymen, alike, as "a most wonderful SIGHT," and the company's Bingham & Garfield railroad is being exploited almost exclusively as a grand "scenic line." And in this respect it may be mentioned that it is now reported that the line is to be connected up with the Saltair bathing train road so that trains can run from this city to both "resorts"—Saltair and Utah Copper's "Mountain View," at Bingham. Just think of "a self-contained manufacturing enterprise" of the boasted magnitude of Utah Copper playing for the nickels and dimes to be made through the 25c. ando $1 fares that the operation of this "scenic line" may provide. Then compare the cost of mining, which we have shown from their reports to be not less than 75c. a ton, with the 24c. a ton cost of their little neighbor, the Ohio Copper, which possesses no steam railroad or spectacular steam shovel operations, and you have a picture which should furnish food for the serious consideration of the investor.

"IT IS TO LAUGH"

Shortly after the first of the month Daniel Guggenheim sailed for Europe. According to the interview he gave out before his departure he was not in his

usual good humor. He very evidently is piqued and disgruntled and altogether disgusted with his adopted country, so he has pulled out for the "Faderland" and other portions of the European continent, according to the Boston News Bureau, for the purpose of "looking after European financial interests of his companies." In other words, the family has not been able to hoodwink the investing public of America to any appreciable extent for the past few years, so the gentleman decided to toss a few boquets at England, Germany and France, pack his grip with Guggenheim Exploration stock certificates and other gilded evidences of long "deferred" wealth and sail away determined to bring back the coin.

When a man gets "down on his luck," it is not considered good form in him to curse the land and smite the hand which has given him refuge and made it possible for him and his kin to bask in the sunlight of prosperity such as the Guggenheims have enjoyed for lo these many years, and under conditions and the employment of methods which, had they been attempted in Germany, for instance, would have resulted in their banishment from the country, bag and baggage. And to think that the head of the house of Geggenheim is now in Europe explaining that American investors have declined to buy their "securities" and that he is there for the purpose of presenting them with the good things which the investing public of the United States failed to appreciate, is to draw the curtain aside and obtain a glimpse of a scene which, stripped of its grotesque setting, borders on the pathetic.

We must quote from the utterances of Mr. Guggenheim to show how bad he feels over the failure of the American public's refusal to be parted from its money and how he unwittingly, perhaps, discloses his anguish at not being able to make his copper and gold schemes work out as he would have them do:

> We have at our doors the empire of Alaska. I am wondering what Germany, France or England would do in case they owned it. I am confident that within five or ten years after a thousand miles of railroad are constructed in Alaska, that territory will reproduce from two to three hundred millions of dollars annually.

A great many people in this country are wondering what Mr. Guggenheim and those associated with him would have done in case their schemes to control the coal, copper and gold resources of that rich country had prevailed. What was "Brother Simon" sent to the Senate of the United States for and what happened after it was found out what the game was. The Guggenheim failures in Alaska and the refusal of the government to come to their relief is one of the sorest spots on the Guggenheim business anatomy. We don't know what Germany, England or France would do with Alaska, but we have a lingering notion that it will not be controlled by and made to pay any particular tribute to the Guggenheim family. Nor is it likely that the Government will buy that 300 miles of railroad that was constructed for the purpose of selling shares in a copper mine that was touted as the biggest thing in the world, but which they knew all the time was of indifferent worth.

> We have had four years of bitter and unreasoning hostility to capital, and the result is painfully apparent, while the great countries of England, Germany and France have had enormous prosperity. We have greater natural resources than those three countries combined but we have been driving our capital away and it has been utilized in building up other countries, instead of being employed in the development of our own.

Of course Mr. Guggenheim guages our lack of prosperity by the failure of the American public to absorb stock at tremenduously inflated prices in the schemes with which he is so prominently identified. He is irritated to think that Utah Copper, Braden, Copper River, Yukon Gold and other propositions have not been converted into real money. This must be so, because it is conceded by every authority that this country has been enjoying usual and substantial prosperity for the four years he complains of. The only particular in which there has been a halt has been in a stock-market sense. Mr. Guggenheim has probably had as much to do with that as any one individual in this country and his recent attempt to get from under by reducing the par value and correspondingly increasing the number of shares in the Guggenheim Exploration Company and then listing the new stock, shows how keenly he feels the lack of confidence the public has shown in the stocks owned by his Exploration company. His idea has been that because of the standing and past earning ability of the Exploration company he could make a market for those shares and thus indirectly accomplish the same object that the marketing of Braden, Yukon Gold, Copper River, Utah Copper and other holdings of the Guggenheim Exploration Company which the public have refused to buy under their own titles, would have done. But it is said the public are not taking kindly to this newly prepared offering, either, and hence the departure of Mr. Guggenheim as above indicated for foreign shores.

In New York, even, Mr. Guggenheim's interview commanded anything but respect, and the Evening Post treated one his profoundest utterances in a most unbecoming and flippant manner, as follows:

> But for the distractions of politics, the obstetrical observations of Daniel Guggenheim, on sailing for Europe, would doubtless have received the attention they deserve. "We have now, as I see it, prenatal prosperity," he said, in his annual interview, "which, if allowed to be born, will, I believe, grow into the greatest this country has ever experienced." Alas! he fears it will not get born (mark the consequences), and that, if born, it will never grow to regular size, owing to the manner in which capital, which is the sire of prosperity, is continually antagonized. However, there are now four shares of Guggenheim Exploration Company stock where there was but one before, and the four shares of $25 each are selling in the aggregate for more than the one of $100 par value **ever was believed to be worth.** That is doubtless the strongest possible tribute to the importance of pre-natal influences upon even such things as securities.

In closing let us suggest to Mr. Guggenheim that the American public has simply come to the conclusion that when it makes investments there must be something behind the claims of prospectuses other than reckless pretenses of worth, manipulated reports and inexcusable bad management in the handling of properties.

HAMMOND—AND HAMMOND

Discussing the copper share market last month Mines and Methods took occasion to quote from a New York correspondent's letter to Mining and Scientific Press in which, it develops, the correspondent blundered in using the name of Mr. John Hays Hammond instead of John Hays Hammond, Jr., as a delegate to the International Wireless Congress in London and also as experimenting with a device for the control of torpedoes by wireless. This explanation would not have been necessary on our part had it not been for the fact that someone—probably connected with the senior Hammond's offices in New York—must have mailed to Mr. Hammond at Lookout Hill, Gloucester, Mass., a clipping of the paragraph taken by us from and duly credited to the Mining and Scientific Press, omitting the accompanying comment. This seems evident because Mr. Hammond, in a note to the editor of Mines and Methods says:

> In the June issue of Mines and Methods I am referred to as a delegate to the International Wireless Conference in London. You pay me an honor I do not deserve; it is my son, John Hays Hammond, Jr., who is the delegate in question. Do you think I ought to call him to task for his endeavors indirectly to curtail the use of copper in the production of which my friends and I are so largely interested? Curiously enough, he is also experimenting with a mechanism for the control of torpedoes by wireless; while I am advocating universal peace and disarmament!

Concerning Mr. Hammond's query as to whether we think he ought to take his son to task for indirectly working to curtail the use of copper and for experimenting with contrivances that will have a tendency to make war more terrible, our answer, it seems ought to be: "Yes; take him across your knee and use the family slipper unsparingly. We cannot afford to see anything done that will interfere with the extended use of copper metal or in any way cripple the copper mining industry."

TRYING TO BOOST UTAH OVER BACK OF OHIO

About three weeks ago the mining department of the Salt Lake Tribune contained an article on the subject of "Copper Ores and Their Real Value" which, at first glance, seemed to have no other purpose than to show that mining values rarely came up to the sampling estimates of the best engineers. To illustrate the points sought to be gained by the writer the Ohio Copper property and the Nevada Consolidated were selected. The article attempts to show that while a number of eminent experts and engineers sampled the Ohio with results so uniform that it seemed impossible a mistake had been made, yet the results of mining ore were not at all up to the grade which the sampling indicated should be obtained. Then it is shown that the early estimates of values in the Nevada Consolidated were fully verified by the grade of the tonnage mined up to the beginning of the present year. The article was rather cunningly constructed, and the fact did not appear conclusive that it had been promulgated with a purpose of not only injuring Ohio but as a means of boosting Utah Copper, until the appearance of chapter two, five days later, in the issue of July 17.

When this second article appeared it was plain that the first one had simply been designed as a prologue to the main play: that of making an apology for the fall in grade of the ores of Utah Copper, but at the same time to show that, because of the enormous tonnage handled, it did not much matter whether the rock treated was ore or only "probable ore."

The first article indicated that the engineers were on trial; the second article gives them a splendid coat of whitewash and declares, in effect, that it cannot be expected that a mine will produce up to the average of the sampling; but, as is the case with Utah Copper, Nevada Consolidated and some of the others, the superior methods of mining and milling employed, it is contended, will make them win.

By all who have been following the history of Ohio Copper it will be remembered that the samplings were conducted and the stated values found by the eminent engineers referred to at a time when the sale of property or bonds were under consideration. Of course these facts did not, in any way, influence the reports submitted, which were made as any other reports might be—such, for instance, as those made for the Utah Copper company and others.

This second article unmistakably discloses the source of inspiration supplying the text for both and it illustrates to what extremes the Utah Copper-Ray-Chino crowd will go in an effort to stem the tide of public distrust and disgust with which they are being met in the mining share markets at home and abroad.

These comments are not designed to belittle the value of the low-grade copper mines. Properly managed and handled, with intelligent methods employed in the separation and collection of the values the ores may contain, Mines and Methods believes they are destined to make and become important factors in the world's supply of copper. When a property like Ohio Copper can be made to show handsome profits on ore the copper contents of which is barely one per cent—when treating a comparatively insignificant tonnage—the possibilities of this class of mining becomes apparent; provided, however, that as sane methods as are employed by the Ohio Copper—as evidenced by its reports—are put into practice. It is supremely unjust, and unfair, therefore, for a paper to hold a crippled and struggling enterprise like Ohio up to ridicule in order to boost the game of such a recklessly extravagant and overplayed proposition as that presented in the form and name of Utah Copper.

In the meantime we are reliably informed that the grade of the ore treated by the Utah Copper Company for the past three months has been nearly or quiet as low as that of the Ohio Copper, whilst its recoveries, at the same time, have persistently fallen considerably below 55% and frequently under 50%, as compared with 55 to 60% as credited to the Ohio Copper in the articles referred to. And that, because of such falling off, it became necessary to begin the remodeling of the remodeled Arthur plant during the past month.

FALLACIES OF MARKET REPORTS

Reviewing market conditions a little more than two weeks ago a New York correspondent of the Salt Lake Tribune said:

> Banks are discriminating against copper securities. The are refusing in many instances to make loans at all unless other securities accompanying the copper. This has given strength to the persistent rumors of a secret surplus of copper that is not being reported by the producers.

These market prognosticators have a hard time of it and most of their troubles arise from the fact that they seldom know what they are talking about. In a letter sent out a few days previous to the one from which the above extract wast taken it was declared that "all the facts and arguments on the constructive side of the market are fully disclosed and there is not another word that can be said in favor of higher prices."

Now, let us see. In the first place we have it on unquestionable authority that eastern banks are not discriminating against copper SECURITIES. It is the copper issues which, through misrepresentation concerning their worth and the partially successful efforts of their sponsors to make them appear respectable, that the bankers are fighting shy of. The bankers of New York and Boston are not discriminating against Amalgamated Copper, Anaconda, the Lake mines, the Phelps-Dodge mines, Miami, nor any other proposition that has the goods and is doing a legitimate business. The bankers apparently are simply protecting themselves by making distinctions; they are shaking out the chaff from the wheat. Neither are the banks becoming discriminators because of the supposed hidden hordes of the red metal; but there is abundant evidence to indicate that the banks of the east are steering away from those propositions the integrity of which the great investing public has come to doubt. Bankers are only human, and when they find that a discriminating public refuses to buy certain offerings they naturally protect themselves and their clients by withdrawing their support from such offerings.

Nor is our friend, the New York correspondent, right when he says that there is not another word to be said for the constructive side of the market. He has become so blinded through viewing everything from the fake boosting side of the game and his vision has become so narrowed thereby, that he has failed to see that the real trouble has been caused by the fraudulent tactics of a few combinations bent on going to any extreme to make their wares marketable. For many, many months this journal has been pointing out to the world what the real difficulty with the copper share market has been and still is. The investing public has not been slow to see that we were standing on firm ground, and now the bankers of the country are finding out.

We do not believe that the rumored hidden surplus of copper metal has anything at all to do with the present dullness and softness of the copper share market. In fact, we are not prepared to believe that there is a surplus that is more than sufficient to sustain a stable and healthy influence on the price of copper metal. That certain interests

have been praying for a run-away copper metal market in order to create a stampede for their shares which they would have as widely "disseminated" as the ores in their mines, there is little doubt; but these prayers have not come from men behind the companies and mines enumerated above. The latter have been and are content to see the metal main tain a fair profit-making level, anywhere between 15c. and 20c., and they are not bothering about the market price of their mining stocks. Neither are the banks.

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NOW FOR SOMETHING NEW

Well, what's the matter with introducing the public to something new? It is now quite evident that market followers have become sufficiently acquainted with the officially promulgated preorts on Utah Copper, Ray Consolidated and Chino to distrust their accuracy and to question the methods employed by the management to make the various properties meet expectations, so why not now give the public a taste of "disseminated" zinc and move the stock-market manipulating steam shovels on to the "deposits" flanking the holdings of the Butte and Superior properties in Montana? D. C. Jackling has been interviewed at Butte, where he stated that zinc was THE metal at present and that there seemed to be immeasurable quantities of it in the Butte-Superior section of the Montana copper camp. Almost immediately following this expression of opinion came the report that J. M. Hayes, cashier of the Utah Copper Company and President Colvin of the Butte and Superior company, had been taking options on all obtainable properties flanking the Butte and Superior. It was also naively stated that much of this property might eventually go to the Butte and Superior company, unless it should be finally decided to organize new companies to exploit it. This movement may be also suggestive of an application of the methods applied in Arizona, where the Ray Central and other property was taken over greatly to the advantage of the managing or inside forces of the corporations involved.

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"Supposing" said the examiner, "you had renewed the manhole gaskets, had tightened up the nuts on the manhole dogs and had got 125 lb. of steam, what would you do if a dog came off and the handhole plate fell in?" "I'd go in after it," answered the candidate. "Any plate that could fall in against a pressure of 125 lb. would be worth going after."—Exchange.

D. C. Jackling, general manager of the Utah Copper Company, left Wednesday night for Butte, Mont., where he will spend two days inspecting the Butte and Superior mine. On Monday he will sail from Seattle for Alaska, his objective point being Juneau. His trip is purely of a business nature and he will be gone about a month.—Bingham Review, July 5. This sounds as though Manager Jackling had decided to take a few lessons in REAL methods of mining and milling at the Treadwell properties, where dividends are EARNED and paid out of legitimate profits, with pleasing regularity.

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A new agreement has been entered into between the Butte miners' union and the mine operators that is to remain in force for three years. The new agreement, it is said, stipulates that, irrespective of the price of copper, the minimum wage of underground workers shall be $3.50 per day, and of surface men $3 per day; that when copper is 15 cents and under 17 cents a pound, underground workers shall receive $3.75 a day and surface men $3.25 a day; that when copper is 17 cents and under 18 cents, underground men shall receive $4 per day, and surface men $3.25 per day; and that with copper selling at 18 cents a pound or better, surface men shall receive $3.50 per day.

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According to the annual report of the Anaconda Copper Company the development work carried on during the past year has not been as extensive as usual, due to the fact that some of the mines were closed down for repairs and various improvements and to the fact that some shafts were put out of commission, but notwithstanding this there were 30.7 miles of drifts, crosscuts, upraises, winzes and shafts added to the work of the year. In spite of the fact, however, that the development was not as extensive as in previous years, the ore reserves were maintained for the reason that the ore was not extracted. The mines of the company produced 184,070.20 tons of ore and 4,602.61 tons of concentrates during the year, making a total of 388,672.81 tons.

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Accidents are more common on night shift than on day shift, and it has been proposed that the midnight shift, in particular, be forbidden. The Royal Commission on Mines in New Zealand, which investigated the matter, came to the conclusion that night work in mines, as elsewhere, "may be more detrimental to men than the day shift, but not so as to warrant us in making any recommendation thereon."

TEMPORARY STAGING HANGERS

By L. D. DAVENPORT.*

The hangers or suspensions illustrated in the accompanying sketch are used for supporting temporary staging in the Chisholm mine on the Mesabi range in Minnesota. The hangers are used in pairs to support a pole or beam, across two of which planks are laid to make the staging.

Clamps or large staples or boards spiked to the timbers in the drifts were formerly used for this purpose, but are open to the objection that they cannot be used on frozen timber.

The first hangers of the type illustrated were made with a pin or bar connecting the two hooks instead of a ring as shown. The hooks act in the manner of cant hooks, the greater the weight, the more firmly do they take hold of the timber. A spur on the heel of the hook prevents swinging.

These hangers are now used in the "slice" rooms at the Chisholm mine. They can be used on timbers ranging from 6 to 24 in. diameter. One of the hangers in each set is made with detachable tongs in order that they may be used with a yoke or handle as timber carriers. They may be also caught into a cap or post and used to hold a snatch block for lifting heavy timber.

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The rapid spread of the use of concrete for varied purposes above and below ground indicate that in it an important structual material has been found. The use of concrete, has, however, spread faster than the knowledge of its properties, and of the requirements for its mixing and placing has spread. As a result much defective concrete work has been and is being imposed upon the public. The use of concrete is so simple that many people think that no special knowledge is necessary in order to have success with it. This is not the case. Concrete that is not mixed and placed according to correct methods cannot be relied on to give good service.

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* Night foreman, Leonard holm, Mont., in Eng. and Mi

Faults of Mining Laws and Remedial Suggestions

By HORACE V. WINCHELL.*

The question of national mining laws is of special interest just now in both Canada and the United States. Attention has been widely called to the many defects and general insufficiency of existing statutes, and wherever the matter has been discussed, the need for revision has been admitted. In the United States during the past decade there has been frequent agitation of the subject. Public officials connected with the administration of our land and mining laws have urged legislation along certain lines; the Director of the Geological Survey and the Secretary of the Interior has engaged the attention of Presidents, Mr. Roosevelt and Mr. Taft discussing it in messages to the Congress. Associations and societies of various descriptions, after due consideration, have passed resolutions demanding this or that measure of relief, and in some cases committees have been appointed for the purpose of making recommendations as to the principles to be followed in new legislation. Thus, a few years ago a committee of prominent mining engineers, among whom were John Hays Hammond, and James Douglas, united in a report upon this subject to the Government at Washington; but nothing came of it, and so far as I can learn, the report was never even published. More recently the matter has again been agitated and committees for its consideration have been appointed by the American Mining Congress and the Mining and Metallurgical Society of America.

The United States might well profit in this matter by the very sensible and systematic method which has been adopted in Canada to facilitate the proper settlement of this most important question. Here, as I am informed, a committee of engineers and attorneys has been selected by the Canadian Mining Institute to draft a bill for a Canada Mines Act, and to present the same for consideration and adoption by the Dominion Parliament. In other words, you Canadians are proceeding in the best way to procure laws framed by experts; and no one can doubt that statutes thus prepared are in every way superior to enactments whose subject matter is prepared by theoretical political economists on the one hand or by agitators and professional politicians on the other. I wish, therefore, at the outset to commend the Canadian Mining Institute for its very wise procedure in this matter and admonish you not to weary in well-doing, not to be disheartened at slow progress. When you have accomplished what you have set out to do, you will not only have that pleasant sense of satisfaction which succeeds the consciousness of duty worthily performed, but you will have made an investment of time and labor which will return a thousand-fold in actual wealth and prosperity. For that country which is willing to be guided as to the handling and development of its mineral resources by the crystallized policies of its mining engineers is the country whose mining industry will be at once best managed and the most productive of material blessings for all the people.

*Presented to the Canadian Mining Institute at the Toronto meeting, March the 6th.

DIFFERENT SYSTEMS OF MINING LAW.

The mining laws of a country are those legislative enactments or customs established by precedent which control the acquisition and tenure of "mining regulations" which have to do with the methods and appliances used in operating mines. The principles underlying the mining laws of various countries have been found susceptible of classification into two groups: "(1) The concession system under which the state or a private owner of mining property has the right to grant concessions or leases of such mining property to individuals or corporations at discretion, or under certain general restrictions. (2) The claim system, under which any individual, under certain general specified restrictions, generally as to nationality and color, has the right to locate on discovery or otherwise certain limited areas of ground, and under certain conditions to hold, work, and dispose of the same."

Under the concession system the right to grant lies with the owner, and it is said that five-sixths of all the mining areas of the world are held under it; under the claim system the right to claim mining ground lies with the locator or discoverer. The latter is the system underlying the laws of Canada and the United States, as well as South Africa and Australia; but there are fundamental differences in these countries as to the nature of the possessory right and the character of title finally obtained.

Originating in the ancient proprietary rights of kings and fuedal lords to the minerals in the ground, the concession system still prevails in more or less modified form under all the ancient civilizations of the world. Its chief advantage is in the retention by the state of the right to select and control the operations of its concessionaires, thus assuring proper capitalization and development, good management, economical use of raw material, and the payment of rental or royalty. To this system there have been objections as follows: (1) that it places unduly large property control in the hands of a few men, and takes from the poor working man the chance of sudden wealth; (2) that by destroying competition in the sale of mines it places in the hands of the holders of large concessions the power of unlimited capitalization and speculation; (3) that it leads to the tying up of large areas of mining ground and thus restricts the employment of labor and the mineral production of the country. To these objections it may be answered that a relatively small number of men will always have control of the money with which to buy and develop mining property, no matter how it be granted; that the Government may easily regulate the capitalization of its lessees; and that a large, strong corporation is usually better prepared to thoroughly prospect its territory than the unaided though far more numerous prospector. If diligent prospecting is required as a condition in the concession, the system of preference rights to explore large areas with the further right to take out leases of limited area would seem to present many practical advantages for new and unexplored countries.

The claim system grew out of conditions in early mining days in the United States and Australia. The Argonaut horde who invaded California in 1849 and a few years later rushed to Australia were in many cases allowed to make their own local rules as to size of claim, method of discovery, staking, recording, and obtaining title. In the United States the usages thus established were later sanctioned by Congressional enactment which grew into our present system of

mining law, and also served to greater or less extent as a model for Australia and other nations. This system, "however necessary in the peculiar circumstances of its inception, should have been altered as soon as changing circumstances permitted," but instead it has been patched and interpreted by judicial decision until the United States has today the most wretchedly inadequate and antiquated law with which a great country is anywhere afflicted. Instead of fostering the mining industry the law as it stands today and as interpreted by the judicial and executive branches of the Government creates confusion, entails unnecessary expense, causes waste, and retards development.

Two fundamental principles are common to the mining laws of all countries: (1) The right of the mineholder to a perfectly secure and indefeasible title to his property so long as he fulfills certain specified conditions entirely within his own control, and (2) the right of the state or other landlord to certain rents, royalties, or taxes on the property or its output, and to the reasonably constant operation of the mine.

In the power of the Government to fix the rate of royalty or taxes lies also the ability to promote or to discourage prospecting and mining. If the chief aim of the Government is the development of national resources and the increase of general prosperity and business, its policy for the disposition and holding of its mineral lands will be most liberal. If there is a desire to enrich the public treasury directly by means of revenues from taxes upon mines, the result may be a rapid decline of the mining business, and a shifting of the population to more favored communities. It is frequently stated, and truly, as I believe, that the principal factor in the growth and development of the United States and Canada has been the liberality of their policy for the distribution of their public domain. Freely, or at a nominal consideration, homesteads and mines have been offered to all who chose to come and settle, to develop and use. If during the past fifty or seventy-five years the policy of conservation as now advocated by its most ardent proponents had been expressed in our statutes North America would be for the most part as little developed as Alaska. There would be a line of settlements along the Atlantic and a few fishing hamlets on the Pacific. The interior of the country would still be to a very large extent bottled up and conserved; and the country would perhaps be still importing the bulk of its copper and iron as it is its supply of tin, platinum, potash, and nitre.

MINERAL WEALTH OF UNITED STATES.

To speak to an audience of mining men of the importance of a liberal mining law is like carrying silver to Cobalt or copper to Butte, but since these remarks may find a wider audience a few words upon the extent of our mining industry may not be out of place. First, with reference to the United States. The annual product of the mines of the United States now exceed $2,000,000,000 in value. They contribute 65 per cent of the freight traffic of the country. The industry employs over a million men at the mines and twice that number in handling, transporting and manufacturing the products. The total value of our metallic products during 1907 was $900,000,000; of mineral fuels, $788,000,000; and of non-metallic mineral products other than fuels, more than $378,000,000. During the year we imported mineral products to the value of $250,000,000, and exported mineral products to the value of $340,000,000. From the beginning of coal mining in this country in 1814 to the close of 1907, there were mined nearly seven billion (6,865,000,000) tons. Adding to this the one-half additional supposed to have been wasted in mining, gives a total of more than ten billion tons taken from the supplies originally available. The amount of easily accessible and available coal in the United States exclusive of Alaska, is estimated as 1,400,000,000,000, while the total, including Alaskan reserves of 150,000,000,000 tons and the coal not easily accessible, is perhaps double this amount and the country is as yet but partly explored. It may be remarked in passing that since the United States is now mining about 500,000,000 tons of coal annually we would appear to have a coal supply sufficient for about 6,000 years at the present rate of consumption, even without borrowing or buying from the enormous coal bins of Canada. Can anyone doubt that the provisions of the laws governing the disposition of the fifty million acres of coal land still remaining in the hands of the Government is a matter of importance to a nation with an annual coal consumption of five tons per capita?

AREA OF PUBLIC LANDS.

Figures are wanting as to the quantity and value of other mineral products estimated to remain within the unappropriated public domain. The land area of the United States, excluding Alaska and the insular possessions, is about 3,000,000 square miles, or 1,920,000,000 acres. Of this area over half is arable, and a little less than half is occupied as farm land. About two-thirds of the land has passed into private holdings. Of the original acreage there remained on July 1, 1908, 387,000,000 acres, or about one-fifth open to entry. Nearly all of this is arid or otherwise unsuitable for settlement by families. There are also about 235,000,000 acres in national forests, national parks, and other lands reserved for public use. Of the entire area of 1,920,000,000 acres there remain unalienated about 622,000,000 acres, or nearly one-third within which valuable minerals may still be discovered. Is it not a matter of vast importance to provide most carefully for the exploration, disposition, and development of this vast empire? In what direction can the fostering care of government be more profitably and properly extended? And when Alaska, with its undeveloped area of about 360,000,000 acres and the island possessions with 90,000,000 more acres, are taken into account, is it not clearly one of the largest questions before the public today?

CANADIAN CONDITIONS.

In Canada the percentage of unappropriated public domain is larger than in the older country lying along its southern border, and there is yet ample time to avoid the mistakes of omission and commission of the United States. With a total area of 2,118,814,000 acres, you have still in the hands of your Provincial and Dominion Governments the larger part of your acreage. Your annual production of minerals is valued at about one hundred million dollars. At its present rate of increase it may easily amount to $500,000,000 by 1950. Can your engineers find any more truly national work than to aid in the framing and adoption of the best possible laws for the protection and encouragement of the mining industry? Is it not apparent that there is a very close connection between mining laws and that conservation idea so dear to the imagination of the majority of our people today? If the true aim of conservation be "maximum use with minimum waste," is it not evident that to be consistent with this theory, mining laws must be liberal as to opportunity and inducement for the individual or corporation, and at the same time as scrupulous and exact in supervision and scientific regulation as the conditions of industry and the laws of political economy will permit? If the terms and conditions for acquiring mining property be so difficult as to materially restrict the number of prospectors or development companies, there will be far less than "maximum use"; and if no right of supervisory control is retained by the Government there will seldom be "minimum waste." The best code of mining laws will inevitably aid in the development of natural mineral resources, and at the same time have a tendency toward the right species of conservation, as contradistinguished from that variety of it which seems to aim at disuse, stagnation, and paralysis.

URE OF AMERICAN MINING LAW.

any particulars the present min- of the United States is admit- failure, and in other respects it th its critics and defenders. I to mention briefly some of its and some possible amendments, ause there seems to be any dan- t our worst faults will be copied rs, but in the way of general il- ion of a question which is not al- learly understood even by our ople.

ly stated, the United States min- , known as the Act of 1872, pro- or location by discovery; posses- rpetuated by annual assessment and title in fee simple to the sur- d minerals obtained after the ex- re of a certain amount of money payment of $5 per acre, and the ance of certain formalities as to , etc. The metal-mining laws do ply to all of the states. They are applicable to the western states rritories with the exception of an, Wisconsin, Minnesota, Mis- Kansas, and Texas. Mining loca- are not recognized in the states f the Missippi River, nor is there state legal authority permitting an to prospect or mine beneath rface of ground owned by another t consent of the latter. To this ent there is one important excep- nd that lies in what is called the law" under which the owner of tcrop of a vein in mining claims e right to follow and mine the n its downward course beneath rface of a claim owned by an- This law has proved more pro- e of expensive litigation than of nical mining, and in many of the recently established and more pro- ve mining districts has been made ative either by common agreement compromise between adjoining s. Placer mines are likewise lo- by discovery and held by annual and acquired by purchase in fee- forever. Known veins within pla- cations must be declared and paid parately or else they are excepted the placer patent and can be lo- by others as "lode claims." All on placer ground not known to at the time of application for pa- belong to the grantee, but without lateral or apex rights. If an appli- for a placer patent can be shown ve had knowledge of a valuable within his lines prior to the mak- f his patent application, his title that vein may be cancelled for at any time upon application of testing locator. There is no limit e time for such contests and they are still being brought in some cases twenty years after placer patent. The law is very defective on this point; for it frequently happens that veins discovered to-day have a value by reason of improved transportation facilities or metallurgical processes, although these same veins were of no value whatever when the placer claim was located and patented. The owner of such a claim is sometimes put to the expense and annoyance of defending such contests repeatedly, since there is no limit to the number of contestants. The law should be amended so as to make it impossibel to attack a placer patent on such charges after a reasonable term of years. Another absurd feature of the placer act is that providing for the location of oil, gas, iron ore, and other deposits in the same manner as auriferous gravel. Coal lands are sold by the Government upon an appraised valuation, and the amount of land that may be legally acquired is limited for an individual to 160 acres and for an association to 640 acres. Tracts of such limited area do not often justify the installation of the most efficient equipment, and economical operation is therefore impossible under the terms of the very law which was expressly designed to promote economy and prevent monopoly.

ABSENCE OF LEASING.

Under the present United States law there is no general system of separation of surface from mineral rights, no leasing of mines from the Government, no payment of royalty, and no Federal supervision or control after location and patent. Taxes are paid to the state and county, and mining regulation is attempted by many states. Unfortunately there is no uniformity of principle and practice as to these matters, nor any stability, nor assurance of permanence in any state either as to methods of operation required or basis of taxation.

Although it has been successful elsewhere and has much to recommend it, the Government leasing system has never met with much favor in the United States. There is not at present strong opposition to grants in perpetuity by the Government, although the leasing system has been recommended by some organizations and public officials. There is a hesitancy to create more bureaus; for bureaucratic administration is not popular with those who have tried to transact business with many of them.

Aside from the generally condemned apex law, there are two or three features of our present system which should be speedily remedied. The first is that provision of the law requiring a discovery of valuable mineral before location. There is really no sense in such a requirement. What seems valuable to one man is often worthless to another; and what is of no value to-day may be worth a million in a year or two. Moreover, it sometimes requires a year's work and a shaft of several hundred feet deep before the actual discovery of ore, even though the surface indications give ample promise of its existence below. Every mining engineer and geologist knows that many ore deposits have no value whatever immediately upon the surface of the ground. Why not allow a prospector to stake out his mining claim wherever he chooses on the public domain, and hold it so long as he performs the required amount of development work?

Another defect in our present law is that permitting a prospector to locate an indefinite number of mining claims and to hold them without doing his assessment work. Many promising districts are kept from becoming hives of industry and producers of mineral wealth by the tying up of their territory in this way. The prospector should be restricted in the number of his locations, and real development work should be exacted.

The last important defect in the United States and Alaska mining and land law to which I wish to call attention is the lack of any provision for appeal to the courts from the decisions of administrative officers. It is contrary to the general spirit of our institutions and an anomaly in constitutional government to take away from any citizen property rights to which he considers himself justly entitled under the law, by the mere fiat of an appointed government official who is here to-day and gone to-morrow. To place in the hands of such officials the final dicta in matters involving property valued at hundreds of thousands of dollars, and to provide no method of appeal to any duly constituted non-political judicial tribunal is not only to subject the said officials to great and unnecessary tests of moral courage and fidelity, but to require in them the qualifications of superior judges and experience in the interpretation of the law which many of them cannot be expected to possess. Serious injustice may be done without any remedy at law to the defeated applicant. In the interests of justice, provision should be made for appeals in important cases, and perhaps in all cases, from decisions of the Commissioner of the General Land Office or the Secretary of the Interior to some court of competent standing and jurisdiction, whose decisions could and would be accepted by the public and the interested parties as justified by the law and

evidence. I am gratified to notice that this point has been carefully covered in the recommendations of the Canadian committee on this subject.

ENGLISH AND AMERICAN SYSTEMS.

A comparison of the mining laws of the United States with those of other English speaking countries will disclose a fundamental difference in the underlying theory of the proprietorship minerals, and hence the attitude of the courts upon the subject as reflected in their decisions. Recent publication of a report upon the "Mining Laws of Australia and New Zealand," has caused considerable discussion because of the fact that its recommendations have been to a certain extent adopted by other government officials in their annual reports and public addresses. This report apparently assumes a similarity between British laws and those of the United States in certain respects where actually a wide difference exists.

"Neither regalian right, nor anything similar, has ever existed in or been asserted by the United States. While it has sovereign authority, and the power to enact such statutes as Congress in its wisdom sees fit, within the limits of the Constitution, its right is dependent upon and controlled entirely by statute." Furthermore: "A distinction exists, and should be observed between ultimate ownership and right to govern on the one hand, and the exercise of regalian right after possession and title is parted with, on the other. The former exists in the United States, the latter does not. The ownership, as well as the manner of exercising control, of mineral lands is regulated in the United States by statute."

"The fundamental principles of the common law of England were to a certain extent ingrafted into our legal system when we separated from the mother country and were and still are the rule of action in the absence of legislation. As a general rule, under the common law minerals were the property of the owner of the land, the property in the surface carrying with it the ownership of everything beneath it. Wherefore the ownership of the surface was the best prima facie title to the ownership also of the mines. This prima facie ownership continued until rebutted by showing either: (1) that the land contained 'royal mines'; or (2) that it was subject to some particular custom that defeated the prima facie ownership, as in the case of the tin mines of Cornwall and Devon and the lead mines and minerals had become in fact, from divers causes several and distinct from the ownership of the soil and surface."

By the term "royal mines" was meant mines of gold and silver. These belonged exclusively to the Crown, by prerogative, although in lands of subjects. In this respect the rule was the same as under civil law. It was at one time contended that mines or mineral deposits containing the baser metals in combination with either gold or silver were royal mines. This contention, however, was set at rest by statutes enacted during the reign of William and Mary, wherein it was declared that no mine should be deemed royal by reason of its containing tin, copper, iron, or lead in association with gold or silver. Thus, those mines only came to be classed as royal in which were found the precious metals in the pure state. Briefly stated, the regalian right to mines, as recognized in England, was confined to those of the precious metals, gold and silver. The base substances belonged to the owner of the soil, except in certain localities where immemorial custom had modified the rule.

At the present time "England has no general mining laws. Legal questions governing the ownership of mines and minerals have been determined on the general principles of the common law."

As distinguished from the common law the theory of the civil law is thus clearly stated by H. W. Halleck:

"All continental publicists who have written upon the subject lay down the rule, that mines, from their very nature, are not a dependence of the ownership of the soil; that they ought not to become private property in the same sense as the soil is private property; but that they should be held and worked with the understanding that they are by nature public and they are to be used and regulated in such a way as to conduce most to the general interest of society."

C. H. Lindley has presented concisely the theory of our leading mining lawyers as to governmental control after patent, as follows:

"The Government of the United States does not concern itself with mining lands or the mining industry after it parts with the title. This title vests in the patentee absolutely to the extent of the property granted. No royalties are reserved; nor is any governmental supervision (except perhaps in the isolated case of hydraulic mines in California) attempted. Upon the issuance of the deed of the Government the mineral land becomes private property, subject to the same rules as other property in the state with reference to the transfer, devolution by descent, and all other incidents of private ownership prescribed by the laws of the state. Briefly stated, property in mines, once vested absolutely in the individual, becomes subject to the same rules of law as other real property within the state."

DID UNITED STATES WAIVE RIGHT?

But lately we are told that the United States "has never waived its right to the precious metals," and that "in all states where the Federal Government has never owned the land, and there are nineteen such states, the ownership of the precious metals lies with the state government," and "that in states where the ownership of the land has been vested in the Federal Government the ownership of the precious metals in like manner, lies with the nation, and that as against the Government no person has a right to gold and silver in any lands in the United States unless this right has been specifically granted to him in the deed of conveyance."

Here is a most radical difference of theory. Mr. Veatch would have the Government dominion and control of gold and silver and by implication of other metals beneath the surface of all lands except those in which minerals were specifically conveyed. He thinks the Government has the right to grant prospecting permits beneath private property and the power to collect royalties on minerals produced as a result of such explorations. In other words he insists upon it that the United States is in possession of a regalian right, but does not know it or has forgotten it. He would have the people wake up and seize what is theirs from all mine operators who are thus wrongfully removing from the ground valuable minerals never specifically granted to them by the Government. It can readily be seen that it is a matter of no small moment to ascertain whether such a thing is possible. Here is proposed mining law revision with a vengeance. I have not at hand the figures to show the relative proportion of lands patented as mineral lands and in all other classes; but have no doubt that the lands granted under the homestead, pre-emption, desert land act, private entry, townsite, timber and stone, railroad grants, and all other laws exceed in the aggregate the lands under the mining laws four to one. Now, if the minerals under three fourths of the privately owned land west of the Mississippi, and practically all the lands east of it, really belong to the Government, it is high time for the Government to assert its right and to exercise some sort of control over its vast possessions. This is either a nebulous and iridescent dream or a very important discovery. If the former the bubbles should be punctured, and the mist dispelled, before arousing too many false hopes; if the latter the work of mining law revision at once assumes paramount

importance. Fortunately, we have some illuminating opinions of the United States Supreme Court, as a guide and cloud dispeller.

OPINIONS OF SUPREME COURT.

In the case of Deffeback v. Hawke, 115 U. S., p. 400, Mr. Justice Field, after reviewing at length the various acts of Congress relating to the public lands of the United States, concludes as follows:

It is plain from this brief statement of the legislation of Congress, that no title from the United States to land known at the time of sale to be valuable for its minerals of gold, silver, cinnabar, or copper, can be obtained under the pre-emption or homestead laws or the townsite laws, or in any other way than as prescribed by the laws specially authorizing the sale of such lands, except in the states of Michigan, Wisconsin, Minnesota, Missouri, Kansas. We say "land known at the time to be valuable for its minerals," as there are vast tracts of public land in which minerals of various kinds are found, but not in such quantity as to justify expenditures in the effort to extract them. It is to such lands that the term "mineral" in the sense of the statute is applicable. In the first section of the act of 1866 no designation is given the character of mineral lands which are free and open to exploration. But in the act of 1872, which repealed that section and reenacted one of broader import, it is "valuable mineral deposits" which are declared to be free and open to exploration and purchase. The same term is carried into the Revised Statutes. It is there enacted that "lands valuable for minerals" shall be reserved from the sale except as otherwise expressly directed, and that "valuable mineral deposits" in lands belonging to the United States shall be free and open to exploration and purchase. We may also say lands known at the time of their sale to be thus valuable, in order to avoid any possible conclusion against the validity of title which may be issued for other kinds of land, in which years afterward, rich deposits of mineral may be discovered. It is quite possible that lands settled upon as suitable only for agricultural purposes, entered by the settler and patented by the Government under the pre-emption laws, may be found, years after patent has been issued, to contain valuable minerals. Indeed this has often happened. We, therefore, use the term known to be valuable at the time of sale, to prevent any doubt being cast upon titles to lands afterward found to be different in their mineral character from what was supposed when the entry of them was made and the patent issued.

And in the case of the Colorado Coal Company v. the United States, 123, U. S., p. 528, Mr. Justice Matthews uses the following language:

"A change in the conditions occurring subsequently to the sale, whereby new discoveries are made or by means whereof it may be profitable to work the veins as mines, cannot affect the title as it passed at the time of the sale. The question must be determined according to the facts in existence at the time of the sale. If upon the premises at the time there were not actual 'known' mines capable og being profitably worked for their profit, so as to make the land more valuable for mining than for agriculture, a title to them acquired under the pre-emption act cannot be successfully assailed."

Since these are the opinions of the highest court in our land it is probable that although advocates of radical revision of our mining law may be able to change the form of its superstructure they will hardly be able to mine deep enough to disrupt its solid rock foundations. It will continue to present fundamental differences from the mining law of Canada on the north, and from that of Mexico on the south, but rights already granted will not easily be set aside.

GENERAL CONCLUSIONS.

Summarizing these somewhat disjointed remarks, it appears in general that:

1. The development and prosperity of all countries it vitally affected by the provisions of their laws relating to mines.

2. Greater inducements and more liberal rewards should be offered in unsettled countries than in districts of denser population.

3. Continuous development work should be required and rigidly enforced, but

4. No narrow limit should be placed on the amount of property held by an individual or corporation so long as the aggregate amount of work equals the product of the net units of area held multiplied by the amount of development required for each unit area.

5. In case of any contest either between rival claimants or between a locator and the Government full privilege should be given of appeal to the courts as in other matters wherein the title to property is involved.

In addition to the above, and with particular reference to the United States, taking into account the system of mining law there already established by long years of precedent and custom, the following recommendations are tentatively presented:

(a) The apex law should be abolished.

(b) Mining claims should be located regardless of a "discovery" and held only so long as the specified development work is performed in good faith.

(c) Placer locations should be limited to deposits of loose materials above solid bedrock.

(d) A statute of limitations should establish a reasonable term of years beyond which placer patents shall be immune from attack on the ground of misrepresenatation in the patent application.

(e) Special statutes should be enacted providing for the location and working of oil, phosphates, rare earths, haloids, and other mineral substances not specifically mentioned in the present laws.

(f) Existing titles should be fully recognized and confirmed and no effort should be made to create retroactive legislation.

I have purposely avoided any discussion of the relative advantages or disadvantages of permanent alienation of title as opposed to the government leasing system. For Canada, I am confident the latter system is to be preferred, and am pleased to find myself upon this point in accord with the majority of Canadian mining men.

An English chemical house is building a chemical works in Russia for the production of iodide of potassium and of sodium, also camphor. The raw material for the production of these products will be the marine growths on the eastern Siberian shore. This will be the first production of such chemical goods in Russia.

The scheme for tunneling the Bering straits and thus linking up the railway systems of Siberia and North America is again being revived, representatives of an American syndicate being at present in Europe for the purpose. The scheme involves the construction of a 40-mile tunnel beneath the straits and the building of new railways both in Siberia and northwest America to reach the approach stations on each side, and would enable passengers from any European capital to travel to New York and the principal cities of the United States and Canada by train journey throughout. It is proposed to sink shafts from islands situated midway in the Behring straits, thus enabling construction to be begin simultaneously from various points, and these shafts would subsequently be employed for ventilating the tunnel.—Exchange.

Copper smelting equipment is in course of erection at the Kalatinsky mines in the upper Isset district, Russia. The ore is a cupriferous pyrite containing as high as 3% copper.

New Wet Centrifugal Separating Process

By WILLIAM J. GEE.*

The new process here discovered is a mechanical method of separating the solid matter from the water and, in the same operation, grading it. The process consists in passing the liquid containing the solid matter in suspension through a rapidly rotating drum, whereby the solids are caused by centrifugal force to be deposited on a removable lining on the inner surface of the drum, while the water or other liquid passes away clear of suspended matter.

The apparatus is seen in sectional elevation in Fig 1, and in cross section in Fig 2. The drum (A) fitted with a base (B) is mounted on a shaft or spindle (C) the whole being suspended from a ball bearing of special design at (D) supported between girders at (E). Rotation is imparted by the pulley (F) to which a band-brake is fitted at (G). The upper end of the drum is closed by a cap (H) which makes a water-tight joint with the drum at (I) when clamped by the locking-ring (J). This forms a species of bayonet joint. The cap (H) has a hole in the middle and is held central on the spindle by means of the casting (K) which is a sliding fit on the spindle, and is connected with the cap by the upper end of the six rods (L). At the bottom of th drum at (M) is fitted a weir plate or diaphragm.

Depending from the cap into the drum is a kind of cage, or "container," seen best in the section, consisting of six vertical square rods (LL) to which are attached radial vanes or blades (NN). These blades extend the whole length of the drum, being connected to the cap at the top end, and to a circular plate (O) at their lower end.

The container slides easily in the drum, which is divided into six longitudinal compartments. Each compartment is provided with a curved plate (P). It will be understood that the container is, in effect, a removable lining to the drum, on which the recovered solids are received, as shown in the horizontal section (Fig. 2) at (Q). The operation of the machine is as follows:

The requiste speed (usually between 100 and 200 ft. per second peripheral velocity) being attained, the water containing in suspension the solid matter to be separated and graded is fed in a steady stream through the hole in the middle of the cap on to the casting, (K) (Fig. 1), which also serves the purpose of a distributing plate. The centrifugal force generated by the rapid rotation causes the water to fly to the wall of the drum and distribute itself thereon, so that an inner wall of water is soon formed which, when a given thickness is attained, overflows as indicated by the arrow at (R) and passes out of the drum through the holes in the bottom, under the weir plate, (M) at S.

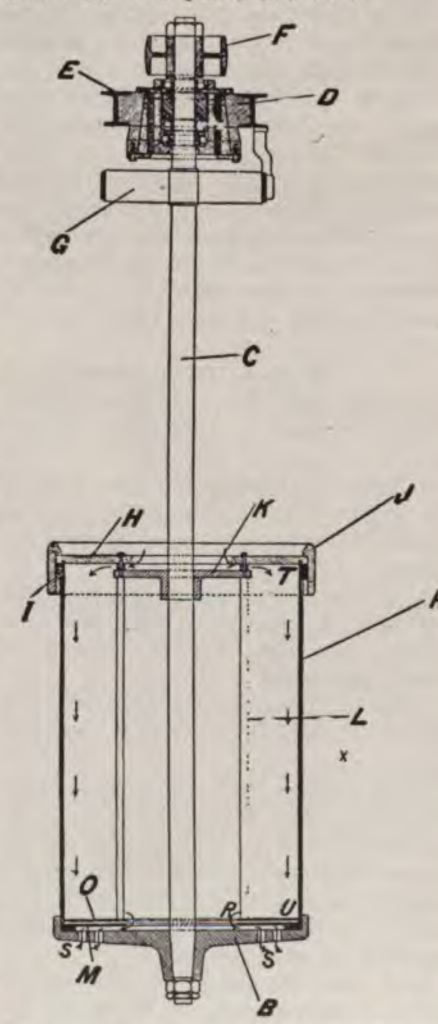

Fig. 1. Simultaneous Separating-Grading

It will be understood that a slow, steady current of water is thus set up in the drum, in the direction of the arrows, and in passing down the drum, the solids in suspension are gradually deposited on the plates which line the drum. The coarse or heavy particles are very quickly separated, and these are found near the inlet at (T). The finer particules are carried farther along before they become separated, until the finest are deposited at (U), near the outlet.

Consequently, the slab of recovered material ranges from the coarsest at one end to the finest at the other, with every possible degree of quality in between. The effluent water is quite clear.

When a sufficient charge of material has been recovered, the machine is stopped, the cap is unlocked, and the container drawn up by lifting gear (not shown) until the bottom plate (O) is within a few inches of the top end of the drum. The container is raised ready for discharging. The curved plates can readily be removed, with the slabs of recovered material adhering to them, fresh plates are inserted, the container is lowered into the drum and locked, and the operation repeated. Four to five "journeys" per hour are made, and each operation in the usual-sized drum (3 ft. diameter by 4½ ft. long) recovers about a quarter of a ton of graded material.

INDUSTRIAL APPLICATIONS.

The industrial applications of the process are very numerous. A large number of commodities, such as whiting, fuller's earth, China clay and other clays, ochres, umbers, and other earthly pigments,

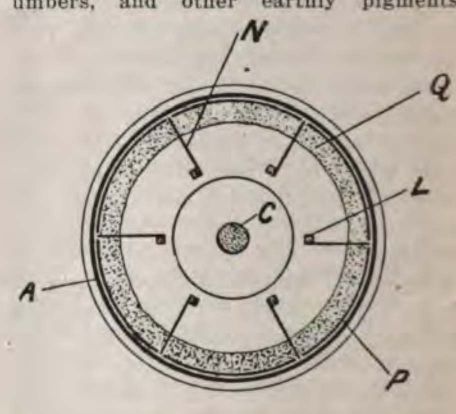

Fig 2. Cross-Section.

Tripoli powder, pumice powder, emery and other polishing substances, and so on, are at present treated by first grinding or puddling them with water, and afterwards settling them out of the water in the various grades, in the manner already indicated.

The machine is also applicable to the separation of solid matter from liquid where grading is of no importance, but where the object is mainly to get the suspended matter out of the water as quickly and cheaply as possible.

A sample of coal was sent to me, containing about 16% of siliceous ash. The object sought was the removal of the silica from the coal. I had the coal crushed to fine powder, and was able to get a very satisfactory result.

APPLICATION TO ORE DRESSING.

I now propose to deal with a new departure made in the direction of apply-

*Journal of the Royal Society of Arts.

ing the process to ore separation. A separator of a new type is illustrated in Fig 3 in sectional elevation, and in cross section in Fig. 4. In this machine we have the drum (A) mounted on the base (B) and closed at the top by the cap (C). Ball bearings (DD) at the top and the bottom of the drum are placed so that the drum may rotate on, but independently of, the shaft or spindle (E). As this ore machine runs at lower speed than the grading machine, there is no objection to putting bearings at both ends of the drum. The weir plate at the bottom, inside the drum at (F) serves, as in the other machine, to provide an inner wall of water of the desired thickness within the drum. The shaft (E) is fitted with bearings at each end, and attached to the shaft, within the drum, but clear of it, are a number of radial vanes or blades, extending the whole length of the drum, and so arranged that the distance for which they dip into the wall of water may be varied, so that the grip of these blades on the water may be adjusted.

The principle of the apparatus is that the drum is caused to rotate at a given speed, and the wall of water is caused by the vanes to rotate within the drum at a greater speed, but in the same direction. These speeds, and their ratio to one another, may be adjusted within very wide limits. The result is that the particles of greater specific gravity—for instance, tin oxide, with a specific gravity of 6.7—are, by reason of their greater inertia, caused to deposit on the drum and remain there, while the particles of lesser specific gravity—let us say, quartz, with a specific gravity of 2.65—are carried along with the water and discharged with the effluent. Centrifugal force acts, in these centrifugal machines, in precisely the same way as gravity does on a concentrating table. The only difference, so far as the effect is concerned, is in the intensity which, in this machine, is about 100 times as great as on the concentrating table. It is easy to adjust the speed at which the water travels relatively to the drum, so as to effect practically a perfect result.

The method of operating the separator is as follows: The drum and the vanes are set rotating at the required speeds, and clean water is fed into the drum until an effluent is observed at the outlet. This indicates that the wall of water in the drum has been obtained. The inflow is now changed to water-suspended ore, whereupon the separation of the metallic particles is effected, as described, during the passage of the material through the drum, and the effluent will consist of water-suspended gangue only. The inflow of ore is continued until a sufficient deposit of concentrates is obtained, and it becomes necessary to discharge the metallic material. The discharge is effected in the following manner: The inflow is changed over from ore water to clean water, and in a short time all the gangue still in the drum will have been carried away and

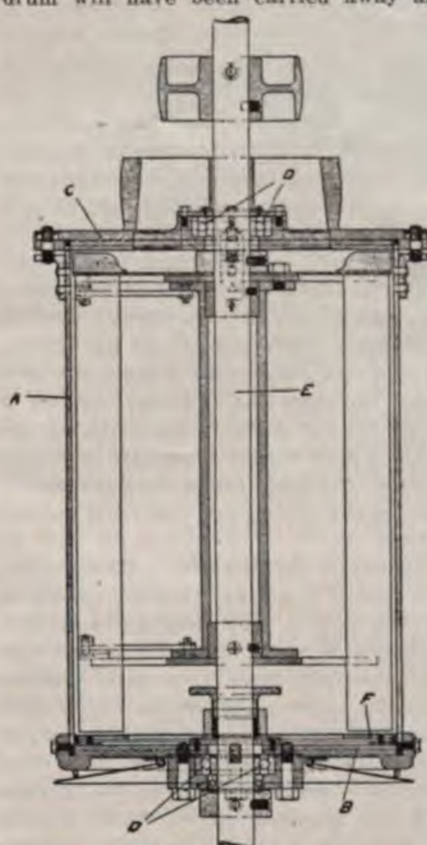

Fig. 3. Special Bearings.

the effluent will be clear. There will now be in the drum only a wall of clean water, with a thin layer of concentrates adhering to the inner surface of the drum. The effluent is now changed over to the waste, and put into communica-

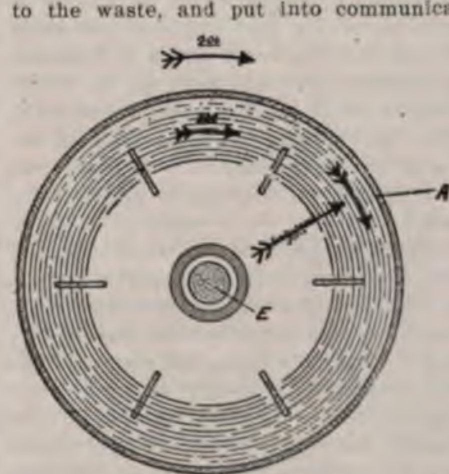

Fig. 4. Special Machine for Metallic-Ore Separation, Vertical Section

tion with the reservoir for concentrates. The drum is then retarded or stopped while the vanes still rotate. The stirring action of the vanes is thereby increased to such an extent that the concentrates are washed off the drum, and the continued inflow of clean water carries them away to the reservoir. In a few seconds the drum is quite clean. The effluent is now reconnected to the waste, the speed of the drum is restored to its proper ratio, the inflow of ore water recommenced, and the cycle of operations repeated. Gearing will be provided whereby these operations are periodically performed mechanically, and the apparatus rendered wholly automatic.

FOLDING POCKET CANDLESTICK

Miners and engineers frequently feel the need of a candlestick for underground work which can be conveniently folded and placed in the pocket. The owner of a pocket candlestick always knows where to find it. Nathan E. Varney of Denver, who has been engaged for some years in the manufacture of candlesticks for miners, has recently procured a patent upon a new device of this kind which he is just now placing upon the market.

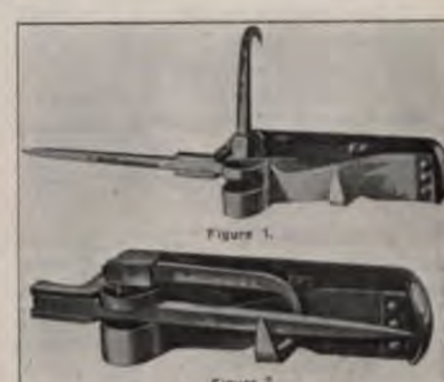

Figure 1.

Figure 2.

Two views of the Varney stick are presented herewith, Fig 1 showing it open and ready for use, while Fig. 2 shows it folded and locked and in condition for the pocket. The essential feature is the means of engaging the base of the hook with the base of the spike, when the two are open, so as to secure absolute rigidity, to which also is added the convenient means by which both hook and spike are properly sheathed when folded. The stick is provided with most satisfactory locking systems when open and when closed. Finally, the closing of the spike compresses within narrow space a spring plate, which at its free end constitutes the thimble or candleholder proper. The compression of this spring when closed gives a certain tension which holds the folded parts tightly in position.

To find the capacity of a cylindrical tank, square the diameter in inches, multiply by the length in inches and multiply this result by .0034. This gives the capacity in United States gallons.

Company Promotion Methods in London

By WILLIAM HILLMAN*

In spite of the great and growing importance of New York as a money center and ever admitting that the "Money Trust" is there developed to its greatest extent, London is still pre-eminent in finance and it is to her financiers that the eyes of all who desire capital are turned. Although many Americans are thoroughly familiar with London financial methods, I believe those who are contemplating financing their enterprises in London will find the following notes of interest.

It is my object in this article to give an account of the usual method of raising money in London for public companies of moderate capitalization, say up to £500,000, and to point out some of the difficulties that an American vendor is likely to encounter. I also wish to show that in spite of its high reputation English company law does not afford adequate protection to the investor, and to indicate how some of these defects might be remedied.

WHERE THE PROMOTER IS ESSENTIAL.

About the first fact that strikes an American who attempts to sell properties in London is that as a rule there is no chance to sell to a group of private investors and that he must depend upon having his property handled by means of a public company; i.e., a joint stock company formed in accordance with a special body of laws, and offering its shares to the general public, usually by medium of a prospectus that is published as an advertisement in the leading newspapers, and is also distributed to individual investors through the mails.

These public companies are formed and their initial expenses are borne by promoters, and hence the chief requisite for doing business is "first catch your promoter." This is an extremely difficult task, for strange as it may seem, the promoter is a shy bird, and his name does not often appear in connection with the companies that he promotes. Though there are directories of directors, and all sorts of classified lists of investors and shareholders, there is no list or directory of London promoters. This retiring disposition of prominent men is quite a feature of London life and is carried to such an extent that some prominent bankers and capitalists do not have their names appear in the directory or in the telephone book.

It is probable that any American visiting London will have letters of introduction to leading engineers and capitalists, and it is equally probable that he will be disappointed when he attempts to do business with any of these people. He will find them so occupied with their own affairs and his interviews so full of depressing interruptions that he will not have a fair chance of stating his own case; the most that he can hope for is to be allowed to leave his maps and reports and to accept a **promise** that they will be carefully examined. Sometimes the reports are opened and read, but not always.

THE GLAD HAND IS NOT EXTENDED.

A typical interview might be somewhat as follows: A long delay in a gloomy cupboard is ended by an invitation into an innner sanctuary by a stolid commissionaire, whose breast shines with medals won in Africa or Oriental campaigns. Hardly do you state your business when your host tells you that he has already had your proposal placed before him, or at any rate a similar one. He regrets that he cannot entertain it at present. You scarcely get a chance to utter three consecutive sentences before he is interrupted by the telephone, and you soon learn that you are talking with a man whose mind is too full of absorbing business to contain any new ideas. He is sure to have a deal of some sort on in the part of the world which is financially fashionable, whether it be West Africa, the Malay states, or, as recently, Nigeria. To him all other parts of the earth are non-existent. "Now if you only had a tin concession in Nigeria I could handle it in a minute. It is so difficult to get anything good there. I am just promoting a property with a capital of £1,000,000 and I cannot handle anything else until this is out of the way." Brr! Brr! goes the 'phone. "Yes, you must get on to him at once, for if he gets away I don't believe we can handle the deal." Then follows a long 'phone conversation, probably touching on gold before it ends. Eventually he turns to you and says in a confidential manner: "You heard this deal I was just talking about on the 'phone. It is practically all settled, and the shares are certain to be oversubscribed. Possibly I could get some underwriting for you if you feel like taking some." And before you know where you are, you will find yourself listening to the details of the promoter's scheme, and all chances of discussing your own proposal vanish. This effective method of getting rid of a visitor who seems likely to prove unprofitable, by leading the conversation to the promoter's own affairs, is so common that I have sometimes thought that it must be laid down somewhere in a "Manual for Promoters."

An intimate acquaintance with busy promoters has convinced me that it is practically useless to try to sell a mine or other property through them, and it is the busy promoter that the American coming to London is likely to meet. It seems, therefore, that his best chance is to get in touch with promoters who are not so busy. These men are equally hard to find, and are usually only to be reached through intermediaries who expect a large slice of profits for their introductions.

PITFALLS FOR THE UNWARY.

Here it seems appropriate to caution the American who is unfamiliar with London methods against giving commission notes or writing letters that can in any way be interpreted as giving anyone a claim on his property. The spirit of Dick Turpin is still stirring, and it is marvelous on what a slender basis of fact the commission hunter works. A stranger to London wiles should at once put himself in charge of an experienced solicitor as soon as he begins serious negotiations.

When a promoter is found who will undertake your business he is sure to want nearly all the rest of your profits—there are, of course, exceptions—and the more successful the promoter, the bigger the slice he takes. I know of one case where the promoter made about £60,000 on a deal and gave the unfortunate optionholder nothing except a call on some ordinary shares; a call which soon became worhtless. In this particular deal a property for which about £1800 was paid in cash was sold to the public on a basis of £130,000. No set rule can be given as to the amount of profits that a promoter requires, but a common formula among them closely resembles the problem set for Alice by the White Queen: "What's one and one and one and one and one and one?" The promoter's formula is: "One and one and one." This expression translated is: one part for purchase price, one part for working capital and one part for promoter's profits. I do not know of any deal that has been put through exactly on this basis, but it is an ideal toward which a number of promoters work.

After the promoter has been found and an agreement reached with him the busi-

*In Engineering and Mining Journal, July 6, 1912.

ness of the American is ended, for he can be of little use in the turmoil of a promotion. However, it seems worth while to give some details of the actual promotion for there is as far as I know but little written on the subject.

AN EXAMPLE OF COMPANY PROMOTION.

As I have remarked before, the promoter raises the money needed for his schemes by selling shares to the general public; his methods can probably be best understood by a concrete example. I give here, with some modification, the details of a promotion with which I am familiar. The property in question, call it the Marianne mine, was first offered for £100,000, but long negotiation convinced the owner that all cash was not to be had and he finally sold for £40,000 cash, and £60,000 in shares. As soon as negotiations were well under way the promoter formed the Maryan Syndicate, Ltd., capital £200 in 4000 one-shiling shares. This syndicate was formed to facilitate the handling of the promotion and also to protect the promoter from any claims that might in future be raised by irate shareholders in case the promises of the prospectus were not fulfilled. The promoter's name did not appear in connection with the formation of the syndicate, the orginal subscribers being three of his solicitor's clerks, whose average pay was £3 per week, and whose total belongings would not aggregate £100—yet the law considered these men of straw good enough to become responsible to the public for transactions involving about £200,000. Men who are anxious to find out who are the promoters in any particular case can best do so by investigating the original subscribers of the promotion syndicate, full details will be given by Somerset House, the record office for London companies.

All the contracts with the vendors, brokers and underwriters were made by the Maryan Syndicate, and the syndicate transferred the property to the Marianne Mining Co., Ltd., which had been formed with a capital of £200,000. Owing to the well drawn porspectus, based on the reports of a prominent expert, and to well chosen chairman and directors, backed by the efforts of strong underwriters, aided by a good press, and, most important of all, owing to the region where the mine was situated being in fashion at the moment, the promotion went off swimmingly and the shares were oversubscribed. The final results of the promotion, omitting details, were £110,000 in cash received from sale of shares, which was distributed as follows: Cost of property, £40,000; working capital, £30,000; promotion expenses, £15,000; promoter's profits, £25,000; or a total of £110,000 cash received, and shares to owner of property, £60,000; shares in reserve, £30,000, so that the total capital of the Marianne Mining Co., Ltd., is £200,000. The promotion expenses in detail were: Legal fees and expenses of formation of company, £1000; printing and postage of 30,000 prospectuses, £500; advertising prospectus, £3200; expert's fee and cables, £1000; broker's fee for allowing use of name on front page, £500; underwriting £110,000 at 8%, £8800; or a total of £15,000 for promotion expenses.

MAILING PROSPECTUSES A BUSINESS.

The 30,000 prospectuses were mailed to possible investors by a firm that makes a speciality of this work and has a large staff of clerks and classified lists of shareholders covering all Great Britain. The advertising was the publishing of the prospectus in about fifty prominent newspapers, the price ranging from £125 for a single issue in the Daily Mail down to £10 for a provincial paper. At the foot of each advertisement was printed a form for application for shares, and it was on these forms that most of the applications were made; few subscriptions resulted from the prospectuses that were sent out by post.

The underwriting, 8% on the cash received or £8800, was a heavy expense, and in this case it was extremely profitable to the underwriters, for as they had, in accordance with their underwriting contracts, to pay in but 10% of the amount underwritten, and as they received this amount together with their underwriting commission within 10 days, they made a profit on the money employed at the rate of 8% per day or over 2500% per annum. It is almost needless to remark that underwriting is not always so profitable. The great utility of the underwriter is as an advertiser and boomer of shares. It is for this reason that nearly all companies have their shares underwritten, though in many cases the expense is probably unnecessary.

THE HAZARDS OF BEING A PROMOTER.

The promoter's profit, in this case £25,000, seems excessive to the outsider, but it is usually divided among a number of people and to one who is familiar with the proceedings of the London bankruptcy courts the profits do not seem so attractive, for the way of the promoter often leads to failure. While the promoter can cover himself for most of his risks, he is bound to advance several thousand pounds for legal costs, expert's fees, cables and printing, on every business that he takes up and if he goes so far as to advertise his outlay will not be less than £5000 on any company that he forms. In case the public does not subscribe for his shares much of his loss is paid by the underwriters, but after his underwriters have been "stuck" once he finds it most difficult to get any new company underwritten. As a result he takes more chances and does his own underwriting, and often lands in bankruptcy. I know of several cases where the promotion expenses have run into thousands of pounds and the amount of shares subscribed for has been merely nominal; in case of a Rhodesian mine the promotion expenses were £5000, and £23 the amount of the shares subscribed.

It will be seen from the foregoing that this cumbersome method of raising money inevitably overcapitalizes the enterprise. Take the case of the Marianne mine, above mentioned; the mine worth £100,000 needed £30,000 working capital and would pay a profit on this, but now being saddled with £200,000 capital and an expensive and incompetent organization, has but a poor chance of success.

Not all companies are failures, and it is to be remembered that the promoter does much useful work in gathering capital from thousands of persons and enabling profitable enterprises to be established. Under the present constitution of society there seems to be no way by which the promoter's services can be dispensed with, and accordingly he will be able to levy his heavy tax on industry for a long time to come. However, the promoter does not set out to serve the public; his chief aim is to make profits, and an almost equally prominent aim is to avoid getting entangled in the meshes of the law. This is at times an expensive proceeding and promoters and vendors have been obliged to refund large sums. One of the most recent cases is that of the Kern River Oil Co., where a large sum of money was repaid by the vendors, and I know of another case where a promoter had to pay £176,000 in damages.

IRRESPONSIBILITY OF THE FLOTATION SYNDICATE.

It was to avoid such consequences that the irresponsible Maryan Syndicate was formed. By working through these irresponsible syndicates the promoter is insured against any claims of shareholders from irregularities in the purchase and transfer of the property, and for any mis-statements in the prospectus the promoter protects himself by his expert's reports in the first instance, and then throws the onus of the prospectus on the directors of the public company, in this case the Marianne Mining Co., Ltd. The directors shelter themselves behind the

expert's report under the advice of solicitors and counsel.

The Maryan Syndicate, Ltd., was a private company, for it did not ask the public to subscribe to its shares, and had a capital of only £200, and this was the maximum amount that could be recovered from its shareholders. But, as a matter of fact, this £200 was never paid into the treasury of the syndicate, and its shareholders were not worth even that small amount. Therefore, the loss that could come to the promoter through the operations of the syndicate would be nominal.

PROSPECTUS CAUTIOUSLY PREPARED.

The greatest risk run by the promoter is in the preparation of the prospectus, for should any shareholder be able to prove that he had been misled by it he would have a good chance to recover his money from the directors, and they in turn would look to the promoter, so there is a possibility of heavy loss should any glaring mis-statements be found in the prospectus. Hence, the preparation of a prospectus is a delicate piece of work and only those on the "inside" have any conception of the vast amount of thought and consultation expended on a well written prospectus. It is first drawn up in a general way by an experienced prospectus writer, who well knows the safe path between glowing fancy and dull fact. His draft passes the scrutiny of the promoter's solicitor and finally a counsellor of note is called on to revise the finished work.

After all it is not the writing of the prospectus that gives the promoter the most trouble, but it is the selection of the men whose names are to adorn the "front page" in bold-face type. These important names are those of the chairman, directors, brokers, bankers, solicitors, auditors and secretaries; the names of the engineers are usually not considered of enough importance to mention.

NOTABLES AND NOBLES DESIRED AS DIRECTORS.

It is in the selection of the chairman and the directors that the promoter shows his capabilities, and the task requires a wide acquaintance, tact, influence and liberality. These are the men to whom the investor looks for a "square deal;" their names are what he first sees, and they have more weight with him than all the rest of the prospectus. Accordingly they must be men in whom the public has confidence, and yet they must not pry too deeply into the mysteries of the promoter's profits and the origin of the reports on which the prospectus is based. The chairman should have a title, for in spite of the failure of many members of the nobility to protect the interests of their shareholders "Sirs" and "Lords" are still of value in the city of London. From the promoter's standpoint, an ex-army officer, or a retired government official is an excellent chairman. Some of the directors should have a practical knowledge of the business that is being promoted.

The anxiety of the promoter to guard against consequences is easily accounted for by the well known high death rate among public companies. It does not seem worth while to prove this mortality, but the result of the West African boom are interesting. In 1901, 260 companies were formed and only 20 were alive in 1911, and of these only five or six have paid dividends and only one has done really well. The records of the West Australian boom are even worse.

In view of the great risk of a failure and of the subsequent attacks by angry shareholders, it is a mystery why so many men of high social position and large fortunes are induced to lend their names to support a business of which they know little or nothing and which is foredoomed to failure from the start. A startling instance was the acceptance by Earl Dufferin of chairmanship of Whitaker Wright's companies. A more modern instance is shown by the appearance of the names of Cornelius Vandervilt and Robert Goelet as directors of the United Malaysian Rubber Co., floated in London in April, 1910. In the opinion of prominent rubber experts, as stated at the time, the company never had the slightest chance of success, and the fact that instead of an estimated profit of £160,000 a loss of over £40,000 was incurred up to May 31, 1911, seems to show that the experts were correct. This case seems even more mysterious than usual for it is admitted that neither of the above gentlemen made any money from the promotion.

Now it is unquestionably the case that when a man buys shares on the strength of a publicly advertised prospectus backed by well known men, he expects to have a fair run for his money, and it is equally unquestionable than in 90% of the companies promoted during a boom he never has a chance of seeing his money again. The companies are formed and the shares issued under the protection of the law, and I hold that if the law was properly drawn up and administered a large proportion of the failures could be avoided. There would still be large sums of money spent unprofitably, but the risks run would be incurred knowingly, and investors would not be hoodwinked as at present.

INVESTOR HAS NO CHANCE TO JUDGE EXPERT'S REPORT.

It is not within the scope of this article to criticize the English company law in detail, but there are two points that seem important enough to discuss, and which should be of as much importance in America as in London. One of the great defects of the present methods of issuing prospectuses is that no chance is given to the investor to properly judge of the expert's report. A requirement that every prospectus should contain a description of the expert's qualifications, the amount of his fee and how it was paid and the name of the payer, the date and duration of his examination would materially aid an investor in judging of the value of the report. These requirements would certainly interfere with the present practice of having reports made by men who know nothing of the business on which they report, or who report on properties that they have not seen for years, or possibly have never visited.

IRRESPONSIBLE PROMOTION SYNDICATES.

Another defect in the present methods is the lack of control over the promoting syndicates. The intent of the law is that the promotion of public stock companies should be carried on in such a way that the private investor should have full notice of all contracts made and of the prices paid for the property that he is buying, and also that these statements should be made by some responsible authority so that the shareholder should have redress in case of mis-statements. But the invention of the irresponsible syndicate has taken away all chance of recovery of damages suffered by the investor. It would seem as if the interests of the shareholders would be much better served if every promotion of a public company were required to be carried on by men of substance instead of men of straw, and if carried on by a syndicate the actual paid-in capital of the syndicate should bear some reasonable proportion to the capital of the company which is being promoted.

When, through carelessness or shortage of water supply, a wooden-stave tank has been allowed to dry until openings appear between the staves, extending downward for some distance, strips or cardboard can be put into the cracks between the staves. The moment the cardboard is reached by the water it swells, stopping the leak. It will also give way to the wood as soon as it begins to swell, and finally decomposes, leaving the tank tight with the staves in their original position.

LEACHING APPLIED TO COPPER ORE* (XX)

COST OF ELECTROLYTIC EXTRACTION OF COPPER FROM ITS ORE

By W. L. AUSTIN.†

It has been shown in previous articles that there is no lack of solvents by means of which copper can be brought into solution out of its various mineralized forms. Furthermore, it is evident to any one who has investigated the subject that from the solutions thus obtained the metals may be deposited in different ways and applied to commercial uses. It is therefore clear, that what is wanted is not so much new processes as efficient application of some of those already in existence so as to produce practical results—the perfection of some one method so that it will stand up under continuous use.

It has been repeatedly pointed out that the efficiency of any process cannot be considered as demonstrated until the said process has been placed in competition with others the values of which have been proven through long usage. Before a method can be commercially applied it must be thoroughly tested experimentally. This can be accomplished upon a small scale as well as upon a large one. The criterion of a leaching process is not that it will treat a car-load of ore at one time, but rather that it will act continuously. With expert supervision a car-load of ore may be successfully handled, although at the end of the run the apparatus may be incapable of repeating the performance without extensive repairs. On the other hand, a process continuously working upon smaller quantities of material—say 200-pound lots—demonstrating that the apparatus employed responds to the calls made upon it, and that the essential qualities of the liquors are preserved after repeated usage, is far more satisfactory to the practical man. The car-load lot experimental works, operating intermittently, may resolve itself into a pit-fall for the unwary: it demonstrates nothing not already known that cannot be better illustrated by a continuously working small plant, and leaves vital issues still undecided.

PERTINENT QUESTIONS ANSWERED.

The question is often asked, Why are leaching methods not more generally applied in the reduction of copper ore? In the first place, some of the old-time processes depended upon the use of chemical reagents which were either difficult to obtain, or when procurable, entailed a heavy tax upon the operation because of the expense. Such methods were those making use of hydrochloric acid, sulphuric acid, ammonia, and other even more costly reagents. Chemical compounds of that nature, when they must be purchased, can manifestly only be profitably employed by works situated close to commercial centers, where chemicals can be cheaply obtained; but this usually involves heavy transportation charges, for copper mines are seldom found adjacent to manufacturing communities. Transportation of acids involves difficulties, and when freight charges have been added to the original price, their cost is prohibitive in remote mining districts. Hence leaching operations dependent upon chemicals brought in from a distance have had an ephemeral existence.

Secondly, when salts such as chlorides and sulphates are employed as lixiviants in lieu of strong acids, the action is much slower, and a considerable period elapses between the time that the metal is taken out of the ground, and disposal of the finished product. This implies a large plant—much expense applied to limited output—and an indifferent attack upon the ore by the weaker solvents. This was the case with processes based upon the use of ferrous and ferric chlorides (chemically prepared), ferric sulphate, cupric chloride, etc. With the exception of Rio Tinto, none of the methods relying upon the use of chemically prepared salts have survived the test of commercial usage.

Thirdly, where electrolytic processes have been tried, often too much has been attempted in one and the same apparatus simultaneously. For instance, it has been essayed to deposit copper, and to prepare a lixiviant in one operation. This entails a fine adjustment of electrodes, current strength, concentration of solution, diaphrams, electromotive force, chemical action, temperature, resistance of electrolyte, etc., which has proven difficult to secure without assistance of depolarizers. All such methods have failed to obtain commercial recognition up to the present time, although in laboratories they give apparently satisfactory results with limited quantities of material over short periods of time. Usually in considering such processes sufficient importance is not attached to the fouling of solutions through continued use, the break-down or anodes, and to wear and tear on the apparatus through attrition and chemical action. The inevitable destruction of mechanical contrivances designed to agitate sharp grains of material in hot, mordant liquors, has been a serious handicap upon all processes employing such means of bringing lixiviant and ore together. Apparatus of this kind can be kept going in laboratories for short periods, but naturally fail to respond to working conditions upon an extended scale. They remind one of some of the older types of pulverizers which could be kept upon exhibition during the day only by using the night for repairs.

Fourthly, correct roasting of an ore to assist in rendering the copper more susceptible to lixiviation has been the stumbling block in some operations. Too much heat produces complications: too little, as well. When possible, it is best to leach an ore in the raw state, because roasting for leaching operations is a delicate undertaking. Nor is roasting necessary in many cases, for there are lixiviants which exert a strong oxidizing action—sufficient to separate copper from sulphur—but it is expected to make oxidation of raw sulphides the subject of a separate chapter.

However, all these adverse conditions may be overcome—will be overcome in fact—by application of practical common sense to the problem, and it will be helpful to the accomplishment of this result when it is not attempted to force conditions to meet the requirements of some patented process. It is not to be expected that all ore should be found suitable for leaching; but such ore as can be leached will yield greater profit per ton when intelligently manipulated, then when treated in other ways.

COSTS OF HANDLING ORES.

As to cost in handling ore, the beneficiation of any ore includes the following items: mining; mechanical preparation of the ore for metallurgical treatment—crushing, concentration, etc.; procuring the medium of reduction—fuel, chemicals, fluxes, etc.; reduction—smelting or leaching; separation of the metals from intermediate products—matte, liquors;

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disposal of waste material—slag, tailings; marketing the products.

As concerns the first of these divisions—mining—the expense entailed in excavating an ore and in transporting it to a metallurgical works, is apt to be the same regardless of method of reduction applied; but of course the advantage will be with a plant situated close to the mine, as against one placed at a distance. Freight charges often consume a large part of the values in an ore, and naturally these will be reduced in proportion to the lessening of cost of transportation Therefore, it is evident that the expense of treating an ore in a suitable metallurgical plant at or close to a given mine, will be less than when the same ore is carried long distances This perfectly obvious fact is illustrated by the establishment of numerous gold and silver leaching plants at mines, the ore of which would not stand expense of marketing as such. Lixiviating is a means of ore-reduction peculiarly adapted to local treatment The necessity of railroads is obviated, which is an essential in the case of smelting operations unless water transportation is available

Most ore requires some sort of preparation before it is ready for treatment by either dry or wet methods. Only a small proportion of the copper ore smelted goes to the furnaces direct from the mine. The common practice is to pass the ore through concentrators, and concentration generally entails very considerable losses. The extent of this waste is hardly realized, but the statistics published by some of the large companies furnish illuminating data. For instance, according to the report of the Nevada Consolidated Copper Company for fifteen months ending December 31, 1911, there were treated by that company by wet concentration 3,338,242 dry tons of ore, assaying 1.8 percent copper. The extraction was 67.59 percent. This indicates a direct loss in the tailings of 38,949,272 pounds of copper for the fifteen months, or 31,259,418 lb. per annum.

WASTE IN CONCENTRATION.

According to the report of the Utah Copper Company for the year ending December 31, 1911, that company treated 4,680,801 tons of ore averaging 1.51 percent copper. The total content of the ore handled was, therefore, 141,360,190 lb. copper. The average recovery in the mills was said to be 69.53 percent, making the loss in the tailings 43,072,450 lb. copper. Hence the reported losses in the wet concentration mills of these two companies alone amounts to 74,231,868 lb. copper per annum. Add to this the losses at the mills at Ray, Chino, Miami, Clifton, Cananea, etc., and the total waste of national copper resources due to use of extravagant methods of reduction, is seen to be enormous. It is useless to compound these tailings for future treatment. A ton of this material contains very little copper to begin with, and when it has been exposed to the weather for some time, (as an inspection of the dumps will disclose), the copper minerals oxidize and the resultant salts are removed by rain.

Examples of the cost of treating large quantities of ore by lixiviation may be obtained from reports of companies which make use of cyanidation in reducing their ore. Whether an ore is crushed to a suitable size in order that the particles of mineral enclosed in the matrix may be liberated and subjected to concentration, or whether it is comminuted for leaching purposes, the expense will not differ materially. In many cases it will be found that very fine comminution will be necessary to liberate fine particles of mineral for mechanical concentration, whereas strong lixiviants will penetrate and remove the same mineral from much coarser material.

As an illustration of the expense incurred in concentrating a copper ore, (which might be taken as comparable to the cost of lixiviation,) reference is made to the report of the Greene Cananea Copper Company for year ending December 31, 1910. During the year named this company milled 670,153 wet tons of ore at a total expense of $0.854 per ton. The recovery was about 75 percent of the copper in the ore, and the horsepower-year cost $78.48. The expense of putting the same amount of similar material through a leaching plant of the same capacity should not be any greater, barring possibly cost of lixiviant —but this latter item will be considered further down.

ADVANTAGES OF LEACHING.

At the works of the Guanajuato Reduction and Mines Company, (a leaching operation being conducted at Guanajuato in central Mexico), according to the company's report for the year 1910 the cost of milling was $1.21 (taking the Mexican peso at 50 cents), and the number of tons milled were 253 357 (2000 lb.) tons. The cost of power was not over $65 per horsepower-year. All ore was stamped through 26-mesh rolled slot wire screens, and the pulp, after passing over concentrating tables, was tube-milled. The average recovery was 81.35 percent of total silver content, and 83.71 percent of total gold. The figures at Guanajuato ($1.21) are higher than those at Cananea ($0.854), but then the cost of chemicals is included in the former, and the quantity of ore handled at Guanajuato was less than half that at Cananea.

It is evident, therefore, that the relative costs of handling an ore in a properly designed lixivation works, o wet concentration mill, are abo same, and the existence of nun leaching plants the world over is that there are no serious mech difficulties in the way of treating quantities of material by leachin cesses. The main obstacle oppo replacing cyanide solutions with ants capable of dissolving copp stead of gold is the mordant act the liquors employed in the latter The problem is to find materials which vessels may be construct pable of withstanding prolonged c with strong acid solutions. Suc sels must necessarily be of large sions, and they must be capable o standing rough usage, but the pr should not be one difficult of solu

As to mining, whether an ore be lixiviated, or treated by wet c tration, the cost may be assumed identical, and as the cost of mech treatment in a leaching plant, o centrator, will also be practicall same, the next item for considerat cost of lixiviant. Incidently it be mentioned that mining expense greatly even when the same comp working a number of mines in the district. For instance, the Canane solidated Copper Company is ope nine mines in the Cananea distric the cost per ton of ore extracted these different properties runs $1.761 at the "Oversight" to $9.7 "Capote," with an average of $2.7 the total tonnage.

If the cost of the lixiviant, an expense for electrolytic deposition metals, be added to the cost of m ical treatment by cyanidation, or b concentration, the total may be us basis of comparison with the cost ducing crude copper bars by the bined concentration and smelting m Referring again to cost of leachin (cyanidation), in South Africa, leaching is practiced upon a very scale, "the average value of th mined is about $.80 per ton," a costs $4.30 per ton to produce the The total expense is therefore $4. ton, including mining at great dept power, at about $70 per horsepowe

DISCUSSION OF METHODS

For the purposes of this disc preparation of lixiviant, and elect deposition of metal, will be taken independent operations—if they c combined in one, the value of the n is thereby enhanced; but, as w plained in a former article, chemi action between the elements form lixiviant can sometimes be effect current densities which are inap ate for deposition of the metal.

Formerly hydrochloric solutions

prepared for leaching purposes by roasting crushed ore mixed with chloride of sodium. At the works of Gibbs, Jackson & Company, in England, muffle furnaces were employed for this roasting. The muffles were 59 feet in length and 12 in breadth (internal measurements). The fumes passed over the muffle, then back underneath through four canals, returning through four parallel canals and then out to the chimney. The gases from the furnaces were conducted to towers filled with coke, down which water trickled. In this way the hydrochloric acid gases were absorbed, and a lixiviant prepared strong enough for leaching roasted ore.

At Alderly Edge, the residual liquors resulting from precipitation of copper from chloride solutions by means of iron, contained much ferrous and ferric chlorides, a small quantity of chloride of cobalt, and much manganese chloride. These liquors were evaporated in iron pans to about 1.4 specific gravity, and then sprayed into a reverberatory furnace. The bottom of the reverberatory was covered with red-hot sand, and the ferric chloride was decomposed, yielding ferric oxide and hydrochloric acid. The gases and steam were conducted to a tower filled with moist coke, where they condensed to a solution suitable for leaching purposes.

The instances cited above might be termed chemical methods of preparing solutions containing hydrochloric acid, as distinguished from electrolytical means of accomplishing this result. It has been stated that electrolysis of a solution of sodium chloride in the presence of sulphur dioxide yields hydrochloric acid, according to the formula: $2Cl + SO_2 + 2H_2O = H_2SO_4 + 2HCl$ (see U. S. Patent No. 973,776, page 1, line 3). It is also claimed that hydrochloric acid may be formed through direct combination of the hydrogen liberated at the cathode with chlorine set free at the anode. Now it is known that electrolysis of a sodium chloride solution at ordinary temperature yields hypochlorites, and that this compound is converted into chlorate by heating the solution. It is also known that hypochlorous acid and hydrochloric acid instantly react with each other, liberating chlorine, and also that hydrochloric acid decomposes chlorates. It is therefore difficult to understand how hydrochloric acid can be produced electrolytically in appreciable quantity under the conditions specified.

On the other hand, as sulphuric acid is formed through oxidation of the sulphur dioxide introduced into the anolyte, whatever free hydrochloric acid is found in the liquor may be more readily explained through the assumption made in the following formula: $2NaCl + H_2SO_4 = 2HCl + Na_2SO_4$. That hydrochloric acid is formed in quantity in the electrolytic vat through the meeting of diffused hydrogen and chlorine ions, especially when a diaphragm is used, requires further substantiation.

To arrive at the approximate cost of electrolytically producing hydrochloric acid for purposes of lixiviation, let it be assumed that the reaction indicated in the formula last given is the one which probably takes place under the circumstances. It is then evident that the interchange of elements had best take place outside the electrolytic vats after the oxidation of the hypochlorites. The cost of the dydrochloric acid will therefore depend upon the expense incurred in producing sulphuric acid from sulphur dioxide.

It has been shown in a former article (Mines & Methods, Vol. II, page 283) that 65 percent of the oxygen liberated at the anode in electrolysis of a copper sulphate solution can be converted into sulphuric acid by the introduction of dilute sulphur dioxide gas (roast-furnace gas) into the anolyte. A simple calculation will show that a cubic meter of oxygen gas at 18° C. (ordinary average temperature) and 769mm barometer, will weigh about 2.95 lb. avd. In Germany, with power costing $0.0125 per kilowatt-hour, it costs to produce oxygen electrolytically approximately $0.156 per cubic meter. Hydrogen is produced simultaneously with the oxygen, and as there are two cubic meters of the latter gas liberated to each cubic meter of oxygen, and as the hydrogen is figured as costing $0.078 per cu. meter (weight 0.1851 lb. per cu. meter), if the oxygen alone is made use of it is assumed that the cost of the hydrogen will have to be charged against the oxygen, bringing the cost of a pound of oxygen up to $0.11.

ECONOMICS OF SULPHURIC ACID.

Theoretically, one pound of oxygen, combining with four pounds sulphur dioxide, will produce 6.125 lb. sulphuric acid. At 65 percent anode efficiency the cost of electrolytically produced sulphuric acid would therefore be $\frac{0.11}{6.125} \times \frac{100}{65} =$ $0.0276 per pound. To produce hydrochloric acid by the action of sulphuric acid upon sodium chloride 0.745 lb. hydrochloric acid will be generated for every pound of sulphuric acid consumed, and about three pounds of sodium chloride is required for every pound of hydrochloric acid generated. With rock salt costing one cent per pound it would be necessary to add three cents to the cost of hydrochloric acid ($0.037) stated in terms of sulphuric acid, making the approximate theoretical cost of hydrochloric acid generated in the manner indicated about $0.067 per pound.

Based on the above calculation, and assuming the ore to be roasted, it is evident from the following formulae that one and one-third pounds of sulphuric acid will dissolve as much copper in the oxide form as one pound hydrochloric acid:

$$CuO + H_2SO_4 = CuSO_4 + H_2O$$
$$CuO + 2HCl = CuCl_2 + H_2O$$

As the theoretical cost of producing sulphuric acid has been shown to be less than half that of hydrochloric, the advantage appears to lie with sulphuric acid as the more economical lixiviant, at least when prepared by action of sulphuric acid on sodium chloride.

If, therefore, it is necessary to roast an ore, it might be found advisable to leach with sulphuric acid prepared electrolytically in the manner indicated by Reinartz (Mines & Methods, Vol. II, pages 281-284), or by Laszczynski (Mines & Methods, Vol. III, pages 368-372). The Reinartz experiments proved that the free sulphuric acid content of a solution could be raised from 0.95 to 5.90 percent, and there is no reason why this percentage would not be further increased. The theoretical quantity of sulphuric acid required to dissolve forty pounds copper contained in a ton of oxidized material is sixty-two pounds, and at $0.03 per pound the expense for lixiviant would amount to $1.86 per ton. Some acid would be unavoidably consumed in other ways than in dissolving copper; but, on the other hand, the total expense of producing this lixiviant might be transferred and charged to the expense of separating the metal, as shown by Reinartz and Laszczynski: that is, in cases where sulphuric acid is employed to leach a roasted ore, the cost of lixiviant might be stricken out under certain conditions.

Sulphuric acid cannot be used as a solvent on some varieties of ore unless they have been roasted, and as it is advantageous to apply the lixiviant direct to raw ore where possible, recourse must be had to some other compound. A solvent that does its own oxidizing may be prepared by electrolysis of a solution containing sodium chloride; but the product varies greatly according to conditions under which the operation is carried out. It is possible in this manner to obtain a very efficient lixiviant, one which both breaks up the copper sulphide and dissolves the copper. The reactions which take place in the electrolytic vat when producing this solvent, are obscure, and it would be difficult to express them by means of formulae. Some experimental tests made with a solution prepared in this way upon raw mineral ground to eighty-mesh, showed an extraction of 65 percent of the copper in fifteen minutes; 73 percent in one hour; and 97.75 percent in three hours. However, there was something

more than simple electrolysis involved in these results, although the expense was not materially increased. The cost of preparing the lixiviant is said to be one cent per pound of the copper brought into solution. The inventor of the process is seeking patent protection, so that the method of preparing this solvent cannot be disclosed at present.

CHLORINE GAS ADVANTAGES.

Sometimes chlorine gas may be used to advantage in leaching cupriferous ore. A method of preparing this gas for metallurgical purposes was described in Mines & Methods, Vol. II, page 121. Today the chlorine of commerce is wholly prepared by employing electrolytic methods. At Niagara Falls, it is stated, chlorine is produced for one cent per pound, and it is claimed that this reagent may be made available in the average western mining camp for two cents per pound. In Mining & Scientific Press of May 15, 1909, the following estimated cost of producing electrolytic chlorine is given. With power at three-quarters of a cent per horsepower, and salt at $10 per ton, the expense in generating one pound of the gas will be:

Power	$0.018
Salt	0.010
Attendance and repairs	0.012
Total	$0.040

No allowance is made in this estimate for caustic soda produced as a twin product. The cell used in generating this chlorine is constructed mainly of cement concrete, and is sold for $575 f.o.b. New York.

Data concerning the Hargreaves-Bird electrolytic cell, of which sixteen were in use at Piedmont, West Virginia, in 1906, can be found in Mining & Scientific Press for January 19, 1907, page 90. The McDonald electrolytic cell is illustrated, and described in full in Engineering & Mining Journal for June 6, 1903, pages 857-858. This cell was used at a chlorination works in Colorado, where it was expected to produce chlorine at $0.0225 per pound.

To bring one pound of copper into solution in the form of cupric cloride theoretically 1.1 lb. chlorine is required. The amount of chlorine necessary to leach a given ore can only be determined experimentally because there are usually other substances in addition to the copper which will be dissolved. Chlorine generated electrolytically may be so applied to the ore in several ways. It can be converted into hypochlorous salts —bleaching powder. Hypochlorites expert a powerful oxidizing action, and may be obtained either by bringing the gas into contact with caustic lime (or caustic alkali), or by electrolysis of a sodium chloride solution at a temperature below 60° F. Another way of applying chlorine is to use ferric chloride as a conveyor. Ferric chloride is a very strong chloridizing agent, readily parting with its third atom of chlorine to mineralized copper, and is then in a form to absorb more of the gas. Once chlorine has been obtained through electrolysis at a cost of, say $0.025 per lb., the additional expense of converting it into a convenient and effective form for application to an ore, is nominal.

(To be Continued).

Copper Deposits of Eastern Quebec

By JOHN E. HARDMAN.*

Half a century ago, or to speak precisely, between the years 1859 and 1865, there existed in that portion of Quebec Province which is known as the Eastern Townships, a very respectable and profitable copper mining industry. The capital invested was almost entirely American and came chiefly from the New England states. Today there are but two properties working in this section which are mining copper, and both of these are owned and controlled by United States capital. The balance of the district is non-productive and idle. It is hoped that the present article may make known a number of facts which will show some reasons for this decline of an industry once so promising, and may indicate that, with modern methods and appliances, a profitable industry can now be inaugurated and maintained successfully.

At the time when copper ore began to be worked and marketed commercially in 1858 the entire production of metallic copper in the United States was about 4,000 tons, and the very high prices which obtained for metallic copper during the American Civil War continued until the highest figure (59¾c) was reached in July, 1864. During the next twelve months, or in June, 1865, this price fell to 29½c, a drop of 30c in twelve months. It must also be remembered that during the decade from 1858 to 1868 the Lake Superior mines first began their commercial production, the Franklin and Pewabic each reaching an output of a million and a half pounds of metallic copper between 1863 and 1865. In consequence of the discovery of the Lake Superior mines, and also by reason of the extreme drop in prices, the American capital interested in the Eastern Townships found a more profitable field in the newly discovered deposits of the Keweenaw Peninsula in Michigan and capital was withdrawn from the Quebec field.

The occurrence of copper in this portion of Quebec, at Brompton Lake, was noted as early as 1841 by Sir William Logan, but before any authoritative printed account was available active mining had begun, and the year 1858 saw the first shipments of sorted ore sent to Swansea. During this year (1858) and those immediately following several Cornish mine captains came out to Canada for the purpose of exploiting these deposits and the names of Captain William Bennett and Captain John Wearne are still remembered in many of the localities where copper ore was formerly mined.

The geology of this section of Quebec has been particularly described in papers by Mr. John A. Dresser, originally communicated to the "Journal of the Canadian Mining Institute" and also published in Volume I of "Economic Geology," 1906. Briefly described the rocks of this eastern portion of Quebec are pre-Cambrian in age and are composed of altered sediments, tuffs and true igneous rocks, the latter being porphyries, andesites and diabases. These rocks have been folded, squeezed, and contorted, forming ridges or anticlines whose general direction is northeast and southwest. In consequence of this folding "lines of least resistance" occur which have afforded passage ways, or channels, for mineral bearing solutions which, by deposition or through replacements, have impregnated the rocks with metallic sulphides of copper and iron, thus forming deposits which vary in thickness from the fraction of an inch to masses occasionally reaching 60 ft. in width. This mineralization of the crystalline rocks appears to have been confined to three ridges or belts running in a northeasterly direction. The first and most westerly of these begins near the southwestern corner of Brome county and runs northeasterly through Arthabaska county; the second ridge commences at Lake Memphramagog and runs northeasterly through the City of Sherbrooke up to and beyond Lake St. Francis, this is the most important of the ridges; the third ridge extends along the international boundary between Maine and Quebec, but has only been prospected in a small

*In Canadian Mining Journal, July 1, 1912.

section near the southern end of Lake Megantic.

These depositions or segregations of metallic mineral usually take the form of elongated ellipses or lenses which sometimes are connected together by a thin stringer of ore, but oftener are entirely disconnected. These lenses are arranged en echelon, and in one of the deepest shafts in the Province, that of the Eustis mine, these lenses have followed one another, and are still existing, to a total depth on the incline of the shaft of 3,300 ft.; in the Albert mine of the Nichols' Chemical company the total depth reached by the incline shaft is between 3,600 and 3,700 feet.

The ores found are divided by their metallurgical characterists into three distinct groups:

(1) Acid, or siliceous, ores occuring in acid rocks, sometimes with a quartzose gangue.

(2) Basic ores of which the base is chiefly iron, occurring usually in contact deposits having diabase for one wall, and typified best by the Memphramagog mine near Knowlton's Landing.

(3) Basic ores of which the base is chiefly lime, and typified by the Acton, Upton, and Ascot mines.

The principal ore bodies hitherto worked have been those belonging to the first class and found in the porphyry-andesite schists, the oldest rocks of the region. Ores of the second class are not so common, but usually occur in large bodies; the basic ores of the third class are quite infrequent. Secondary copper minerals such as bornite and chalcocite occur sparingly and the evidence of secondary action is fragmentary and quite insufficient to permit of generalization. The evidence afforded by the older mines which have been worked continuously is to the effect that the ores continue to considerable depth with undiminished values in copper, silver, and gold.

The townships adjacent to and surrounding the city of Sherbrooke contain fifty or more properties which either have produced a respectable tonnage, or have shown bodies of ore which have been prospected in part, but have not yet been developed. The best known of the mines in this class are the Capelton, Eustis, King, Howard, Suffield, Huntingdon, Clarke, etc. Farthest to the northeast is the old Harvey Hill mine, and in the southwest is the ounce famous Huntingdon mine which has been worked to a depth of about 700 feet.

The values contained in these three different classes of ore do not vary greatly; probably the highest copper values are in the lime-basis ores and the higher silver values with the acid ores. The general average composition obtained from a very large number of samplings gives, for the acid ore, about 60% uncombined silica with from 20 to 25% alumina and iron, and 10% sulphur; the copper averaging 3%. The iron basic ores carry from 45 to 48% metallic iron and from 2½ to 7% copper. In Mr. Presser's article on this subject (previously referred to in this article) he gives the average of the Capelton Hill as from 4 to 5% in copper, 38 to 40% in sulphur, for the properties on the southern slope of the hill; for the properties on the northern side of the hill he gives a smaller average in sulphur and about the same percentage in copper.

Taking into review the general average of all the copper deposits in the townships, and averaging all classes of ore, the percentage of copper may be taken at not less than 3% and the precious metal (silver and gold) contents at from two to three dollars; the average percentage of sulphur lies between 25 and 30%, of silica between 40 and 45%, and of iron from 15 to 20%. To the metallurgist this average analysis indicates a composition that is readily fusible in the furnace.

During the period of activity in the early sixties, several small furnaces and smelting works were built of which only fragments and ruins now exist. All values in these ores, other than sulphur, have been religiously concealed by the companies which have been in existence for over 30 years, and the general public knows of these mines only as containing ores of sulphur and having value only for sulphuric acid making. Undoubtedly this view has been helped largely by the fact that the cinder, after the sulphur has been burned off, has been shipped out of the country to the United States and there smelted, the copper and silver contents being credited to the production of the United States and not to the Province of Quebec.

It must also be noted that during the forty years which have elapsed since the cessation of active work in the townships much railroad building has been done there, and the facilities for shipping ore have been very much increased. Sherbrooke is an important railroad center, having four different lines of railways entering the town, yet renewed interest in the copper resources of the district is still lacking. Investigation has shown that, with the exception of one or two particularly rich deposits, such as the recent discovery at Weedon, the mining of ore to ship and sell abroad is not profitable, and that the hope of a new industry in these ores is dependent upon the advent of smelting facilities which shall be able to treat the ore within a reasonable distance of the mine. The ores offer, if carefully selected, an almost ideal assortment for smelting without the use of barren fluxes. In addition to transportation facilities labor in the townships is cheaper than almost anywhere else in Canada and a large supply of electric power is available for all requirements of mining and smeling.

If the reader will take into consideration a few facts it should seem evident that there is the basis here for a permanent industry; the annual importations of copper into the Dominion are about 28,000,000 lbs. All the crude copper shipped from the large mines in British Columbia and those near Sudbury, Ontario, is sent to the United States to be refined; no refined copper is made in Canada. As to the importations, whether in bars, billets, rods, tubes, sheets, or any other form, 90% comes from the United States and 10% from Great Britain. These facts point to the desirability of the Dominion refining its own production of copper, which in crude form totals nearly 100,000,000 lbs. a year.

The small ventures in copper mining will not be successful, and it is admitted at once that a large capital is required to make the deposits of Eastern Quebec profitable. The deposits are large enough and extensive enough ot justify the investment of large capital and such investment would have a long period of life and a satisfactory profit. Probably the reason why these fields have so long lain dormant is that they are practically at the doorstep of Montreal and too near to enjoy the benefit of that old Cornish saying which declares that "Far away fields look green."

GOLD DEPOSIT OF WILSON MESA

By J. M. HILL.*

Two classes of deposits are worked in the vicinity of Basin and Mesa, Utah. In the mountains there are several quartz mining prospects and at least one locality where placer gold has been recovered. In 1907 it was first noted that the gravels on Wilson mesa carried gold. For two years these gravels were washed by crude methods and in 1910 a little excitement was created in Salt Lake and Grand Junction over the richness of the deposits. That their nature was not understood is clearly shown by placer and lode locations which cover the ground. There has been practically no production from the quartz mines, and it is probable that $5,000 would cover the entire output from both quartz and placer mining in the region.

The flat mesas south of Castle valley are covered by a coating of gold-bearing gravel. This deposit is usually very thin, being indicated by scattered bould-

*Extract from Bulletin 530-M, "Contributions to Economic Geology," U. S. Geol. Sur., 1912.

ers and pebbles or by small, flattened mounds of like material here and there on the standstone bedrock. In a few places it attains greater thickness. Some of the larger deposits stand as low, rounded knobs, but most of them seem to occupy re-entrants in cliffs. The latter was apparently the position at the Point Lookout placer. A combination of the two forms is seen at the Black Cap workings. A third and much rarer occurrence is along what appears to be an old channel which runs northwestward from the Black Cap.

The gravels are the same throughout, consisting of subangular cobbles of igneous material similar to that seen in the La Sal mountains to the east, with a relatively small proportion of sandstone fragments. They range in size from one-fourth of an inch to 2½ ft., with an average size of about 10 to 12 in. Fragments of monzonite porphyry cut by quartz stringers are fairly abundant and magnetite cobbles up to 4 or 5 in. in diameter are not at all rare. There seems to be a slight decrease in size of the boulders at the western edge of the deposits, but it is not everywhere the same and is rather doubtful. There is practically no stratification of these gravels except along the present drainage lines in reworked material.

The gold, said to be worth from $19 to $20 an ounce, occurs in small wires or flakes, and none of that seen appeared to be much water worn. It is distributed throughout the thickness of the deposits, which are said to be of about the same from the surface to bedrock. Besides the gold that can be recovered by washing it has been found that the "ribbon rock" (the monozonite porpnyry cut by quartz stringers) contains a fairly large portion of the gold value of the gravels. Some of the miners assert that for every ounce saved by sluicing 10 ozs. are lost in the ribbon rock which goes over the dump.

There is no natural water supply on Wilson mesa. A ditch originally built for irrigation is said to supply about 12 cu. ft. a second from the beginning of the thaw in April to the last of July, when the greater part of the snow has disappeared from the mountains. From then until October the supply is about 8 cu. ft. a second, and it is further diminished during the winter. The water is all taken from Mill creek, and considerable trouble has been experienced in obtaining enough for sluicing, as the town of Moab also takes its supply from this source and has a prior right to the water.

The Black Cap placer is locater in the cliff between the middle and upper mesas. The gravels here form a low knoll, and are also found below the general rim-rock level in what appears to be a cleft or re-entrant from the face of the cliff. The maximum thickness above the true rim rock is about 50 ft., with possibly as much more below at one place.

Hydraulicking into sluice boxes located in the re-entrant has opened a pear-shaped cut about 40 ft. in maximum width by 60 ft. long, with a face 40 ft. high. The location is ideal for this sort of work, as there is plenty of ground for a dump much below the level of the gravels. It is said that some difficulty was experienced with the larger boulders and that considerable gold was lost in the ribbon rock.

At the Point Lookout placer the gravels clearly occur in a re-entrant at the rim of a conyon leading into Mill creek. This locality is also in the rim of the middle mesa, just above the lower mesa. A very thin veneer of gravels covers an area of two or three acres, with one deeper deposit just at the rim.

A shaft sunk in the deep deposit has gone down about 20 ft. through gravel that contains a large amount of magnetite, usually as small pebbles, though some cobbles as large as 8 in. in diameter were noted. Very little water can be had here. The surface has been partly sluiced into a vibrating screen which allows only the finest material to pass. The fines were put through riffles and finally over a small amalgamation plate. Practically all the free gold was saved, but it was found that the tailings carried gold in the quartz ribbon rock.

At the Butterfly placer a low ridge running from the middle to the lower mesa is covered with gravel to varying depths, a knoll at the lower west end showing the greatest thickness. The main irrigating ditch referred to above passes this place and the gravels were handled by road scrapers, being carried upon a platform through which they fell into sluice boxes. The method was very cheap and it is said that with a team and scraper two men could make $16 a day.

At another locality two shafts about 100 ft. apart have been sunk; one to a depth of 40 ft. is all in gravel and the other, 10 ft. deep, entirely in sandstone bedrock. This is on the relatively flat middle mesa, but in a depression that at present is a water course and seems to have been a channel at the time of the deposition of the gravels. A prospect southwest of Mesa postoffice is also a low knoll of gravel with bedrock outcropping just east of it. This is apparently a remnant behind a ledge of sandstone. A prospect just east of Mesa is a continuation of the Black Cap deposit. It is a relatively thin layer of gravels except in a few shallow re-entrants.

The material composing the gravels of Wilson mesa is at least nine-tenths igneous. It occurs on flat-lying undisturbed sandstones which nowhere show any igneous rock in place. All the porphyry types represented in the main laccolithic mass of the La Sal mountains are represented by pebbles or boulders in these gravels. Pebbles of monzonite porphyry cut by stringers of glassy quartz containing limonite, which resemble the ore of the Tornado mine and other places, are frequently seen. These, owing no doubt to their original altered condition, are softer and more weathered than the previously unaltered rocks. It can hardly be questioned that the gravels were very likely derived from the La Sal mountains. Their present distribution is probably due largely to erosion since their deposition. In sheltered places such as re-entrants the gravels have not been removed, but they have been largely eroded from the flat-topped mesas except for the remnants left in old channels or between the present drainage lines.

The method of deposition of the gravel on the mesa is open to question. That its deposition is not related to the most recent glaciation is clearly shown by the fact that the last glaciers were very small, rarely reaching below an elevation of 10,000 ft. and never issuing beyond the high mountain valley. The material is subangular, no rounded pebbles being noted; it is fairly coarse for the most part, with only a little sand, and it is as far as seen unstratified. Two hypotheses are suggested by its character. Both torrential floods and glaciers form such deposits that one or the other of these agencies brought the material to its present resting place is fairly sure. In either event it is quite certain that the gravels were deposited at a time when the La Sal mountains were higher than they now are, and either explanation presupposes a very much greater precipitation than there is at present in this region. It seems probable that the gravels were deposited prior to the establishment of the present drainage system for deposits of this class are found only on flat-topped mesas, and if ever present nave been entirely removed from the places now occupied by canyons. Similar gravels that were not visited are reported on the mesas north of the mountains.

If these gravels are glacier-borne deposits they must surely afford some evidence of this mode of transportation. The writer at the time of his visit did not fully realize the difficulty of proving this point, so did not spend sufficient time to collect conclusive evidence. One boulder of sandstone 10 ft. in diameter on the upper mesa about half a mile east of Mesa postoffice showed marks that were thought to be striae.

TREATMENT OF GOLD CONCENTRATES

By AL H. MARTIN.

Recovery of major values from concentrates has long claimed the attention of the mine managers. Numerous companies have preferred to ship the product to smelters, but various objections have developed, and the more progressive managements favor the maintenance of refining plants on the ground. When the concentrate is of a character to be handled without particular difficulty, and the property is remote from a smelting plant, the manager is virtually compelled to provide his own plant to recover the high values. Within recent years the larger and more powerful corporations have shown a disposition to refine their own concentrates, and the trend is admittedly in this direction. The practical mining man naturally is not interested in mere theories—he wants something more tangible—something that may be practically applied, something that enables him to earn maximum profits on an economic basis. By the experiments and experience of others he gathers knowledge, and on the results obtained by successful operators he fashions his course. Consequently accounts of successful practice must ever hold paramount interest for the modern gold mine and mill executive.

Prior to the development of the cyanide industry the chlorination process was extensively employed by companies refining their own concentrates, and this method continues to be effectively utilized in favored districts. Generally, however, cyanidation has superseded chlorination, and the more recently installed plants are advanced types of cyanide efficiency. Where the chlorine gas is still used natural conditions are generally propitious, and results excellent. In the earlier days of California quartz-gold mining this process claimed particular favor, and in many of the Mother Lode districts ruins of old plants are fairly numerous. The Mears process, wherein chlorine gas was forced into barrels, was first employed principally, and was later improved by Adolph Thies. By the latter's method the gas was generated in the barrel by charging sulphuric acid and bleaching powder with the ore, and adding necessary chemicals seperately—as is now done in the barrel process. The most important of the chlorination works now operated in California is employed by the Kennedy Mining company near Jackson. The Plattner process is used, modified and improved by experience garnered in long years of activity, with alterations made to suit varying ore conditions. The plant consists of two reverberatory furnaces, leaching and precipitating vats, and lead generators. The furnaces have inside dimensions of 80x12 ft. The plant is exceedingly simple and easy to operate, and its efficiency is demonstrated by the fact that the company has used it for years and continues to perfer it to more modern arrangements. It lies about one-half mile from the mill, the product being transported by a mule-team.

SUCCESSFUL CHLORINATION PLANT.

The material treated comes from the Frue vanners of the 100-stamp mill and the canvas concentrators. Sulphides of iron are the principal composition, with small percentages of copper, lead and zinc sulphides. The product is charged to the furnace through a hopper, only one furnace being operated at a time. The ore contains 7 to 10 per cent of moisture to avoid loss by dusting. Each furnace has a capacity of 7½ tons per twenty-four hours, and sixteen hours represents the period from charging to the discharge. As the charge is moved forward to within about twenty feet of the forward section of furnace, and while a small percentage of sulphur still remains, salt is added to the amount of three-fourths of 1 per cent of the dry weight of ore. This forms chlorides in the furnace with the lime and magnesia occuring in the ore, greatly lessening subsequent consumption of chlorine gas and resulting in lower operating costs. While the addition of salt to the furnace charge is generally condemned, because of loss of gold by volatization of values, in this instance oxidation is nearly completed, and the objection eliminated. While it is probable that some gold is lost, the percentage is so minute that it is deemed of scant consequence.

After the ore has been desulphurized it is removed into a steel car and discharged upon a checker-work floor paved with old mill dies turned reverse side up. The material is stirred at intervals to assist its cooling and later dampened by a jet of water. It is then charged into one of the four leaching vats. These are of cylindrical form, four feet deep by nine feet diameter. Cobbles are laid at the bottom, followed by successive layers of gravel and sand, forming an effective filter. Over this is placed a layer of six-inch boards as a shoveling floor. The damp ore is sifted into the vat through a shaking screen and as soon as the vat is filled within six inches of the top, a cover is lowered into place and sealed with a composition of sand and clay. A folded burlap bag seperates the charge from the cover.

The chlorine gas is introduced into the vat through the filter bottom and the process continues from six to eight hours. In the cover a small auger hole is bored. The circulation of the gas through the vat is determined by removing the plug from the auger hole and holding a bottle of amonia over the vent. The arrival of the gas is immediately signaled by a dense white vapor of amonium chloride. After the charge has remained in the vat a sufficient period, the cover-plug is removed and water introduced. When about four inches of this covers the charge the cover is raised by chain-blocks and the discharge-cock at bottom of vat is opened. Clear water is kept continuously running into the tank, the amount corresponding with the outflow of gold solution. The latter is received by a pipe and conveyed to the precipitating department. The running of solution is carried on until the addition of a ferrous sulphate solution indicates no gold value remaining. When this stage is reached the water is shut off and the tank permitted to drain, a matter of a few hours. Samples are taken of the pulp and should high values still show, the product is removed, dried and regassed. It is seldom that the pulp carries sufficient values at this plant to justify the second treatment.

The gold in the precipitation tank is precipitated by adding ferrous sulphate. The addition of this compound detects the presence of minute quantities of gold, and its employment has been found remarkably efficacious. Precipitation is accelerated by sprinkling surface of tank with a solution of barium chloride, only a small quantity being added by means of a whisk broom. This rapidly clarifies the water, and the gold settles to the bottom. When the water has sufficiently cleared it is removed by a floating syphon to a safe point and the remainder discharged into a smaller tank, where the gold is collected, filtered and dried. It is subsequently mixed with fluxes, melted in crucibles and moulded into a bar for shipment to the mint. The concentrates from the Frue vanners average $80 to $85 per ton, and the product from the canvas concentrators $40 to $45 per ton. In the chlorination plant 92% of total assay values are recovered. Costs average about $5.50 per ton.

SIMPLE CYANIDE METHOD.

An effective method of treating gold concentrates by a simple cyanide method is utilized by the North Star Mines company, operating the North Star properties at Grass Valley, Cal. The ores of this property carry little refractory matter, and for years practically all values were secured by amalgamation and simple concentration on canvas tables. The concentrates from two 40-stamp mills are loaded into a circular wooden tank, having a diameter of eight feet with an eight-foot depth, until ready for treatment. Contents are discharged into a 4½x20 ft. Abbe tube-mill and three pounds of cyanide added to each ton of pulp, the solution being united with pulp before admission to tube mill. The mill preforms twenty revolutions per minute, under sixteen horsepower. From the mill the pulp passes to a set of amalgamating plates and on to cone classifiers. From these the overflow passes to agitation tanks where it is kept in constant activity for six hours. It is decanted twice and the remaining product delivered to an Oliver continuous vacuum filter. Classifier underflow is returned to the mill circulation, and the product of the Oliver filter is precipitated by the usual zinc dust method. Concentrates average $30 to $40 per ton and approximately 93 per cent of values are recovered. Costs average $3 per ton.

This method commends itself to operators of properties where the ore is free-milling, and no particular difficulties are experienced in effecting a fair rate of concentration. At the North Star mill 77% of total values are recovered by amalgamation.

GOLDFIELD CON. METHODS.

The concentrate treatment plant of the Goldfield Consolidated Mines Company of Goldfield, Nev., followed a series of interesting and comprehensive experiments, and is probably one of the most satisfactory and effective ever erected. It was at first considered that roasting would be necessary to recover gold from the concentrates, but subsequent tests proved the feasibility of cyaniding the raw concentrates with extremely satisfactory results. The heavy freight and treatment costs attending the shipment of concentrates to smelters early convinced the Goldfield Consolidated management that the product should be treated at home, and with the coming of J. H. Mackenzie, the shipment of concentrates ceased. At first the concentrates were given an acid wash and agitated for eight hours in Pachuca vats. The pulp then passed to Dorr continuous thickeners. The overflow went to the precipitating tanks and the thickened pulp to a second Pachuca tank and a regenerated solution added. As this meant the pumping of the concentrates each time, with an attendant expense, the method was later superseded by a new arrangement. At present the product is agitated for eight hours and settled and decanted in Pachuca tanks—a method that has proven markedly satisfactory.

From the mill the concentrates pass by wooden launders to four amalgamating tables, having dimensions of four by sixteen feet. The final section of tables is provided with a carpet covering which gathers the gold escaping amalgamation. From the plates the product continues to three 10x20 foot redwood collecting and agitating tanks, equipped with a specially designed mechanical stirring device. Each vat has a capacity of fifty tons of dry concentrate and after the collection of charge it is decanted until the pulp contains about 50% moisture. The mechanical stirring arrangement is placed in action and gradually works its way through the charge until the whole mass is active. About twenty pounds of sulphuric acid are added to each ton of pulp and agitation continued for eight hours. Water is then admitted, the agitator raised and the pulp allowed to settle. After the clear solution has been decanted the pulp is washed twice lime added and agitation resumed. Lead acetate is dissolved in water and added to the charge at the rate of one pound of the compound per ton of concentrate. The agitation continues until the pulp is ready for pumping into the Pachuca vats.

Cyanide solution of a strength of 4½ pounds per ton of pulp is fed into the Pachucas before admitting concentrates. After dewatering and settling the product is delivered to a Kelly filter-press, containing 400 square feet of filter surface. It disposes of 50 tons per eight hours, total capacity equalizing 750 pounds of concentrates and 1,200 pounds of solution per square foot of filter every twenty four hours. The high-grade solution is clarified in a 36x36-inch 60-frame Perrin press and precipitated by the ordinary zinc dust practice. The precipitating department, treating all solutions, includes four 30-frame Merrill triangular presses in its equipment. Precipitates are subsequently placed in a 24-mould Boyd press, blanket concentrates and litharge added, and the whole briquetted. Briquets are completed in eight hours and after being dried are melted on a lead basis in blast furnaces. These are cylindrical in form, with 20-inch diameters, and have a capacity of 15,000 pounds of briquette per twenty-four hours. The lead is cupellated in an English double cupelling furnace and after oxidation is complete the gold is granulated by discharge into water-filled metal tubs. The resultant product is collected, dried, melted with borax and nitre in a No. 60 Steele-Harvey tilting furnace, and shipped to the Selby smelter, at Selby, California. The total extraction of values from concentrates averages 95.23%, at a cost of $5.85 per ton. Of this labor represents $0.93 and power $0.48 per ton. In districts where labor and power costs less than at Goldfield, the total cost would be correspondingly reduced.

ALASKA-TREADWELL CHANGES PLAN.

A radical departure from time-honored customs marked the comparatively recent change of treatment at the Alaska-Treadwell mines. The amalgamated plates are entirely dispensed with at this plant, and the concentrates treated direct by cyanidation. The result has been pronounced exceptionally pleasing, and the innovation has attracted wide interest throughout the mining world. Experiments were conducted under the supervision of F. W. Bradley, consulting engineer of the company, and Robert A. Kinnie, general superintendent. The plant has a capacity of 100 tons per day and is located 200 feet above the stamp mills. The Alaska-Treadwell company operates five mills, comprising 900 stamps, crushing 5,000 tons of ore per day. The concentrates are gathered by 360 Frue vanners, and about ninety tons are produced daily.

From the vanners the product is shoveled into flat-bottomed steel cars having an individual capacity of two tons. Locomotives haul the car-train to the foot of an incline at the cyanide plant building and the product is elevated to a switch above the main cyanide plant building by a Union Iron Works geared hoist actuated by a seventy-five horsepower motor. Most of the water has been removed from the concentrates before being taken from vanners, consequently the amount of moisture carried is small. From the cars the product drops into 100-ton steel storage bins. These have a diameter of fifteen feet and are provided with conical bottoms. The concentrates are kept covered with water and a strong lime solution maintained. The product is sluiced to three Dorr classifiers, which command three Abbe 5x22 tube-mills equipped with spiral feeders. Each mill makes twenty-seven revolutions per minute, and three-inch Danish flint pebbles are employed in grinding. When concentrates are amalgamated previous to cyanidation, the product from the tubes passes over ten copper amalgam plates, plated with two ounces of silver per square foot of surface. Each plate is ten feet long by four feet eight inches wide. From the plates the pulp flows directly into launders terminating and built into the floor, and from the

pump the product is elevated by an air-lift to a spitzlutte, which delivers the coarse material to a Dorr classifier. From this machine it passes to a 4x12-foot Abbe tube mill. The mill's discharge mixes with the overflow from spitzlutte and the combined product is elevated by air-lifts to two settling cones. The overflow of the Dorr classifiers pass through 200-mesh screens into two Callow dewatering cones. The spigot discharge of cones is received by ten amalgan plates. From these the pulp passes by launders into a distributing box commanding two Pierce amalgamators. From these the product continues into four eight-foot Callow cones. The spigot discharge passes to four more cones and thence to a Pachuca tank for agitation, decanting and settling. The thickened pulp is subsequently delivered to another Pachuca tank and given cyanide treatment. Two cyanide treatments are given, after which the settled pulp is delivered to a Kelly filter press. Two of these machines are employed and after the gold solution is mixed with zinc dust the whole passes to two 36-inch, 16-frame triangular Merrill presses. It is stated the rate of extraction exceeds 97% at an approximate cost of slightly over $2.87 per ton.

MANY TESTS PRECEDE CHANGE.

Th new method of concentrate treatment was decided on after over two years' investigation and the expenditure of over $27,000. Abandonment of amalgamation in favor of direct cyaniding was decided on after careful tests and numerous runs, and the results have been more satisfactory than even the engineers estimated. The practice has met with considerable approval from other metallurgical experts, and it seems reasonably certain that similar installations will be provided by other companies treating ore containing the Alaska-Treadwell characteristics.

Numerous special features are included in the equipment, and the special method of feeding zinc dust to the precipitating boxes is worthy special mention. The zinc is discharged directly into a small tube-mill by the zinc belt, and the tube is filled with a series of zinc rods two inches in diameter. These rods not only reduce the zinc dust to a finer state, but themselves yield zinc particles, thus aiding precipitation to some extent. The tube mill is composed of 10-inch pipe and has a length of six feet.

By similar changes and improvements in other portions of the plant the cyanide department has been gradually brought to its present high stage of efficiency. A comprehensive and interesting sketch of this plant was presented by Cyanide Superintendent W. P. Lass at a late meeting of the American Institute of Mining Engineers. The paper appeared in Bulletin No. 62 of the transactions of the society, and to this interested engineers are referred for more complete details. The departure from amalgamation to direct-cyanidation marks a distinctly progressive step—and is a principle likely to receive increasing attention in other gold mining fields.

While cyanidation has displaced chlorination in most fields as the best mode of recovering values of concentrates, the fact that chlorination is still employed by progressive and wealthy companies proves it has many good features. The simplicity of the treatment, and low costs of plants are points in its favor and have incontestibly influenced its use in many instances. But generally speaking the day of the chlorination works nears the unset—and the cyanide process is steadily driving the old process into oblivion. The chlorine gas made gold mining history in past decades, but metallurgical progress is steadily forcing the old to make way for newer and more effective principles.

Way to Success in Engineering Profession

During an address to the graduating class of the Montana School of Mines, last month, E. P. Mathewson, general manager of the Washoe smelting works at Anaconda, kept out of the rut of conventionality and imparted some wholesome advice, illustrated by personal experience, to the students, in the following interesting and entertaining manner:

I want to avoid the pedantic style of oratory and talk to you men, as one who has had a little experience in your chosen profession, to those just entering the arena. It has been suggested to me by your worthy president that I give you some account of my own personal experiences and those of friends of mine who have become prominent in the mining and metallurgical world. If you will pardon my speaking of myself, I will give you a brief account of my career.

After graduating from college, I was fortunate in securing a position as assistant topographer on the geological suvvey of Canada. I had several months experience in that line, returning home at the expiration of the survey.

STARTS IN THE WEST.

I found nothing in my chosen line of work and so I temporarily took a position as clerk in a wholesale establishment, all the time looking out for something in the profession. Nothing turned up that winter, so I made up my mind, after consulting with some friends, to try my fortune in the western United States.

I obtained a letter of introduction from the late Dr. T. Sterry Hunt to a man who was engaged in lead, silver and copper smelting in Colorado. This man had been a pupil of Dr. Hunt and had gone west shortly after graduation and amassed a considerable fortune. I did not know a soul in Colorado, but I met some people in Denver, who gave me the following advice: "Go to the gentleman to whom you have the letter of introduction and present the letter, and if he tells you he has no position vacant, ask him if he will allow you to push a slag pot away from the furnaces." I went to Pueblo, the following day and presented my letter. It so happened that the night assayer had just resigned, so I was offered the position as night assayer of slags and refinery products at the magnificent sum of $50 per month, the work being 13 hours night shift for two weeks and 11 hours day shift for two weeks. I liked the work and it seemed to agree with me.

At the time of my entering the employ of the company known as the Pueblo Smelting and Refining Company there were 13 technical graduates ahead of me. Shortly afterward the manager who had given me work resigned and a new man was put in charge. A little later the metallugist was offered a good position in Australia, and he left. He was followed by the assistant metallurgist, and within a short time so many changes occurred in the technical force that I found myself assistant superintendent in the plant before I had been two years in the employ of the company.

Mine was rather an exceptional case. I was assistant superintendent only one year when the superintendent resigned and I was appointed superintendent of the lead department there being another superintendent of the copper department. Shortly afterward, the superintendent of the copper department resigned and the manager asked me to take charge of both departments; at the same time telling me that the wages of the men in the copper department would have to be cut in half. This was a very pleasant opening, as you can imagine. I went to the foreman of the copper department, explaining my new position and the decision of the management regarding wages. The foreman told me politely that he and his men would quit, which they did.

RUNNING FURNACES BY A BOOK.

I thereupon took some men from the lead department and put them in charge of the copper furnaces. I had never seen a charge of copper refined, but there was an article published in the "Transactions of the American Institute of Mining Engineers" by Dr. Eggleston, which described fully the operation of refining copper in the Lake country. I got this article and camped at the works without sleep for 56 hours, directing the men I had put in charge of the copper furnaces in every step of the process. Whenever I got stuck I would retire to the office and consult the article, the result being that we ladled the biggest charge of copper that had ever been taken out of the furnace, and that charge was of the best quality every taken from that furnace.

After that things went smoothly enough in the copper department, as the men I had broken in took up their work readily, and as they were accustomed to funrace work it was not difficult to train them to handle copper.

I want to say, for the benefit of you young men, that the salaries paid in those days were not what are paid nowadays for similar services. My salary, as assistant superintendent, was $135 per month, and that large sum was only obtained after strenuous efforts on my part to have the management recognize my ability. That was the only time in my life that I ever asked for an increase in wages; but the manager, I knew, had no knowledge of the value of the services of a technical man; and I was aware that in other establishments in the vicinity men in my position were paid considerably more than I was.

I remained with the Pueblo Smelting and Refining Company until 1897. At that time the Guggenheim family had a number of smelting establishments, one of which was in Pueblo. The late Benjamin Guggenheim (one of the Titanic heroes) asked me to enter the employ of M. Guggenheim's Sons and take charge, as manager, of their Philadelphia smelter at Pueblo—the idea being that as soon as I found a man to take my place I should be transferred East. The transfer was made about three motnhs after entering the employ of these gentlemen, and I was placed in charge of the refineries at Perth Amboy, N. J.

During the next five years I was sent out to various parts of the country, including Mexico, and was for two years in South America, at Antofagasta, Chile, representing the interests of my employers.

After two years in South America, I returned to New York and shortly afterward my association with M. Guggenheim's Sons (who had, in the meantime, joined interests with the American Smelting & Refining Company) was served.

A few months later I was offered a position in Montana as superintendent of blast furnaces at the Washoe smelters, then just constructed. This position I took and a few months later, owing to the resignation of the manager, I was placed in charge of the plant and have remained there ever since.

UP FROM THE RANKS.

I will now give you, briefly, accounts of the lives of several men who are or have been prominent in the mining world. First, I recall a friend who was, at one time, employed by the Pueblo Smelting & Refining Company in Colorado. This man was a graduate of Freiberg. He dropped into Pueblo one day without any acquaintance in the town; he applied for work at the smelter; was given a wheelbarrow and shovel and a position as laborer in the sampling mill. He did not mention the fact that he was a graduate of Freiburg, but it so happened that the furnaces were out of order and he dropped a hint to the foreman in charge as to a good way to bring the furnaces around. The foreman reported the matter to the manager and the manager asked him if he knew anything about furnaces. He said he did "know a little," so the manager gave him a trial as an assistant about the furnaces. He proved that he did know his work and gradually he was advanced until he was placed in charge of the plant. Leaving that plant, later on, he took charge of a smelting plant in another part of Colorado, and he was then offered a position as metallurgist to the Broken Hill company, in Australia. This position he accepted with many misgivings, but it proved that it was the beginning of the making of his fortune. He built up the smelting industry for the Broken Hill company and then interested himself in other companies in Australia, finally retiring with a large fortune a few years ago. He still retains an interest in the work.

Another man took a small, humble position with a placer-mining company in California, showed himself to be a good assayer; then later was put in charge of some small quartz properties; from there he was called to South Africa, at the time the Rand was coming into prominence; showed his ability as an organizer in organizing some of the big properties there and managing them, and is today one of the most highly paid consulting engineers in the world.

Anothers man, nearer home, worked for years as assayer in Anaconda then in a similar position on the Pacific Coast, rising to the position of chief assayer at a large plant; then was offered a position as assistant to one of the managers in South Africa on the Rand, which he accepted. He filled that position satisfactorily and was advanced to the managership, and after several years' service in that capacity, returned to America to take up the work of consulting engineer, representing the capitalists who had been his employers on the Rand.

Another man, who began with pick and shovel around a smelter, gradually worked his way up to the superintendency of one of the large Colorado plants, was transferred to Butte, where he conducted some of the earliest experiments in the use of magnesite brick for the lining of converters; from there drifted into the mining end of the business, and is today one of the leading consulting mining and metallurgical engineers of the country.

Another man began as a field assistant to the geological survey of the United States; was afterward state geologist of Wyoming and from there drifted to Arizona, where he became connected with the Copper Queen Mining Co. His ability soon placed him at the head of the technical force of that company, and from that he was transferred to other larger concerns and given more authority, and today is the general manager of one of the largest companies in Mexico.

Another case: A young man sought employment at the Washoe smelter a few years ago as a laborer, said nothing about his technical knowledge, but put in a formal application for a position when a vacancy occurred in the tchnical staff. He was offered a position and we were surprised to find that he had been working for us for months as a laborer. He proved his ability in the technical line and when the opportunity was offered of a transfer to another company, at an increase of salary, he accepted, and today is the assistant superintendent of one of the largest companies in the country.

We have had many young men in Anaconda and in Butte who have worked their way up and today there are dozens of technical men employed about the mines and smelteries who are on the road to advancement.

The main things to be remembered by you are: To be not afraid to tackle any job that turns up. Never be above your position. Be sober and diligent. Faithful in business. True to your friends and to your employers. Learn to treat your associates and the men under you as men, and as soon as you can find the right girl (provided you have enough money to pay for the license), I advise you to get married. Do not wait to make your fortune before choosing your wife; if you do, the chances are 99 in 100 that you will never have one.

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CONTENTS:

It is now currently reported that the Utah Copper crowd has secured control of the Telluride Power Company's Utah and Colorado plants. This move on their part, if true, is commendable. According to report, the Utah Copper Company's power plant cost in the neighborhood of $4,000,000, and it has been able easily to supply power to the company's mines and mills at about double the cost that the Telluride company would have furnished it for. Now, if the Utah crowd gets control of the Telluride company, there seems nothing in the way of securing cheaper power for Utah Cop- [illegible] and mills and an eventual un- [illegible] Utah Copper's power plant [illegible] company as an "aux-

From Copper To "Gold Mines"

This space is reserved for the picture of A. F. Holden, the other eminent engineer who lent his name and gave his endorsement to the electrifying report on Alaska properties submitted herewith and which will be reproduced from month to month.

NOTED ENGINEERS JOIN BROKERAGE HOUSE IN A REMARKABLY PECULIAR PRESENTATION OF AN ALASKA GOLD MIRAGE.

As one of the most remarkable, alluring, and at the same time most deceptive bids for public support of a new mining venture ever made, Mines and Methods herewith presents the offer of Hayden, Stone & Co., with the endorsement of Daniel C. Jackling and Albert F. Holden, engineers of world-wide reputation, to finance the recently-organized Alaska Gold Mines Company. The statements made are remarkable for the care which has evidently been exercised to make them non-commital; they are made alluring to the unthinking and uninformed through the spread-eagle use of figures which, once thoughtfully dissected, will uncover a sufficient number of "little jokers" to convince the searcher after truth that "things are seldom what they seem." Deception is found in nearly every expression from the beginning of Hayden, Stone & Co.'s presentation of the matter, to the last lines of the "report" carrying the signatures of D. C. Jackling and A. F. Holden. This "report" is such a MASTERLY document, measured from a mining engineering standpoint, that we have made an effort to produce the photographs of Messrs. Jackling and Holden, so that the younger generation of engineers might gather inspiration from their beaming countenances while steadying their brains for the supreme task of making engineering worth while to themselves. We have been unsuccessful in securing the picture of Mr. Holden for this issue, but space alongside of Mr. Jackling's picture, it will be observed, has been reserved for him; and it is the purpose to reprint the report of these gentlemen from month to month until the picture is secured. Readers, we are sure, will be interested to know what a man looks like who is willing to lend his name to such a profound document as the "report" referred to.

HAYDEN-STONE LETTER.

Hayden, Stone & Co., present the matter in the following manner, the capitals in the "report" of Messrs. Jackling and Holden being ours, of course:

TO OUR CUSTOMERS:—We are organizing the Alaska Gold Mines Company, to have an authorized capital of $7,500,000, divided into 750,000 shares, par value $10.

This company is being formed to acquire a controlling interest, as par[illegible]larized below, in the Alaska Gast[illegible]

Mining Company, which owns a large, low-grade, free milling gold deposit near Juneau, Alaska, to construct a mill for the property with an initial daily capacity of 6,000 tons, and to finance the development of the property for extensive operation. It is estimated that $4,500,000 will be required for this purpose.

There will be issued at the present time 614,700 shares and the company will hold in its treasury $1,790,000 Alaska Gastineau bonds out of a total issue of $3,500,000, being a majority, and $9,801,000, par value, Alaska Gastineau Mining Company stock, being about eighty per cent of the total capital of $12,000,000. There will be placed in the treasury of the Alaska Gastineau Company $1,250,000, and, in addition, in the treasury of the Alaska Gold Mines Company (the holding company) the further sum of $3,250,000, or a total of $4,500,000 in all.

Construction, equipment and development in an active manner has already been begun.

The balance of the authorized capital of 750,000 shares of the Alaska Gold Mines Company unissued, amounting to 135,300 shares, will be reserved for the general purposes of the company and to acquire, if it can be done on reasonable terms, the outstanding $1,710,000 of bonds of the Alaska Gastineau Mining Company, and the $2,199,000 of the capital stock of the Alaska Gastineau Mining Company.

The shares of Alaska Gold Mines Company will be payable, $5.00 per share at the time of allotment, and the balance of $5.00 will be called on or about July 1, 1913. Certificates of stock marked "$5.00 paid" will be issued as soon as the same can be prepared, and application will be made to list the stock upon the Boston Stock Exchange.

A large majority of these shares has been allotted to the group of gentlemen who will constitute the board of directors who have already been interested in the acquiring of these properties. The balance we propose to allot to our clientele.

We extend to you, subject to prompt acceptance according to the terms hereof, the right to subscribe to these shares at the price of $10.00 per share.

Subscriptions will be received up to the close of business August 28th, and allotments will be made immediately thereafter.

We reserve the right to accept any part of such subscriptions and to reject the whole or any part of any subscriptions. But in accordance with our methods we shall make as near a pro rata allotment as possible.

The character of these properties is, generally speaking, analagous to the low-grade "porphyry" copper mines, in that they contain vast deposits of low grade gold-bearing rock, susceptible to very economical milling. Physical conditions are very favorable for most efficient operation.

The organization of the company will be in part as follows:

MR. CHARLES HAYDEN, President.

MR .DANIEL C. JACKLING, Vice-President, in charge of operations.

MR. ALBERT F. HOLDEN, with the two officers named, and two others, will constitute an executive committee.

We have undertaken this business only after a most thorough investigation by qualified experts, whose reports have been submitted to Messrs. Daniel C. Jackling and Albert F. Holden (than whom no two men are in our judgment better qualified to pass upon propositions of this character). Messrs. Jackling and Holden have subsequently made examination of these properties in person and most emphatically approved their purchase, equipment and development, as may be seen from the extract of their report below.

HAYDEN, STONE & CO.

August, 1912.

* * *

Extract From Report of Messrs. Jackling and Holden.

We have considered the PROBABLE capital requirements for a capacity of 6,000 tons per day, which contemplates a hydro-electric power plant; mine development and equipment, including all the necessary living quarters, both at the Perseverance mine proper and at the mill, and driving the long adit tunnel. We BELIEVE that $4,500,000 will do this work.

Our BELIEF is that the substantially INDICATED ore body is about 4,500 feet long by 70 feet wide. The value of the 600,000 tons of ore THAT HAVE BEEN MINED FROM THIS BODY IN THREE DIFFERENT LARGE STOPES INDICATES that a recovery of at least $1.50 per ton can be made. We BELIEVE that there will be 75 cents per ton profit in this grade of ore. The Sheep Creek Tunnel, which will be driven on the vein as the main haulage level, will develop this ore body at an average depth of about 2,200 feet on the dip of the vein, or about 700 feet deeper than present developments.

The character of this vein is similar in A VERY GENERAL WAY to other large deposits of gold ore in the same vicinity in which the values at a vertical depth of 1,600 feet, or 2,000 feet on the dip of the vein from its apex, are practically the same today as they were on the surface, and have been throughout the development of THE DEPOSITS IN QUESTION. We visited these mines and saw THEIR deep levels, and, if there is any inference to be drawn from the continuity of THESE ore bodies, WHICH ARE NOT, HOWEVER, ON THE SAME VEIN AS THE PERSEVERANCE, one MIGHT BE TEMPTED to say that there is a PROBABILITY of ore 2,500 feet deeper than the so-called Sheep Creek Tunnel which we contemplate driving, BUT, while the PROBABILITY is there of the vein and values extending to great depth, THERE IS NOTHING TODAY TO WARRANT ANYBODY IN STATING THAT IT IS A FACT THAT SUCH WILL BE THE CASE.

There are substantially 50,000,000 tons in the ore body we consider definitely INDICATED. There is a PROBABILITY of another 2,000 feet to the east of the 4,500-foot ore zone previously mentioned, which, from surface indications, would seem FAIRLY CERTAIN to contain ore. Beyond this is some 1,800 feet of the vein concerning which we have NO FINAL OPINION one way or the other, AS WE VISITED NO WORKINGS OR OUTCROPS from which we could secure sufficient data to form accurate deductions. While we cannot at this time state that there IS ore here, there were several SMALL MINES worked almost at the extreme east end of the vein on this property, which INDICATES that this 1,800 feet will undoubtedly produce considerable ore and PERHAPS LARGE QUANTITIES. If we do not consider this in the PROBABILITIES, it is certainly well within the POSSIBILITIES.

This letter is based solely on a consideration of $1.50 recoverable value as ore. If one should figure on lower values, assuming 75 cents as the total cost of mining and milling, the tonnage now indicated in INDEFINITE, but certainly enormous. We BELIEVE that sound mining business will INDICATE that for the installation now proposed and for an operating period of, say, two years, IT WILL BE WISE TO CONFINE OUR WORK TO THE HIGHER GRADE ORE. There can be, in our opinion, little doubt that at some time in the comparatively near future A VERY MUCH LARGER PLANT than the one now proposed will be installed for the purpose of working a larger tonnage of the normal grade ore we now EXPECT will be developed, or of utilizing the apparently vast quantity of lower grade material.

The INDICATED earnings from the installation now contemplated are approximately $1,500,000 per annum. Considering the TREMENDOUS POSSIBILITIES, and we use the word "tremendous" advisedly, we BELIEVE this mine to be a LEGITIMATE purchase at $15,000,000 and A BARGAIN at $12,000,000, provided that, in both cases, a development, equipment and working fund of $4,500,000 is made available. You must understand and appreciate that we do not consider

6,000-ton per day development and illation as the ultimate possibility of mine or anywhere near it. The SIBLE tonnages of ore INDICATED his property APPEAR to be greater any vein deposit WE know about. EXPECT the first unit of the new to be in operation on or before ary 1st, 1915. We really BELIEVE barring accidents, the time MAY be July 1st, 1914.

ted, D. C. JACKLING,
y, 1912. A. F. HOLDEN.

* * *

by any stretch of the imagination stent with engineering rules univer- adopted for the determination of ities and values of ores in place could infer the possible realization antity and value of ore which these ent engineers have assumed to be ated as "possible," "probable," con- nt or existent in the property in ion, then, measured by the actual of operations under the personal vision either of Mr. Jackling or Mr. n upon properties infinitely more ptible to cheap production of metal any cost indicated or possible as ed to the mining and treatment of ore in question this property, her it contains 50,000,000 or 0,000 of tons of "indicated" or real s absolutely without any value what-

course it goes without saying that res of this Perseverance mine must xtracted, if at all, by some method derground work, the operations of shovels being physically impos- and not suggested by these able eers. The lowest rate of cost of rground extraction of ores in the rties of the Utah Copper and Ray olidated under the supervision of Mr. ling is placed in his official reports er 68c a ton. These orebodies are veral hundred feet in thickness, and mely soft and friable in character, hat extraction by any process is aratively cheap, whereas the hard, h quartz of Douglas Island could only emoved at a relatively much higher but if we add concentrating costs ated by the reports of Manager ling in respect to the operation of first named properties—which is 65c per ton—we would have left about 14c per ton to cover addi- l costs of amalgamation and cyani- n, to which the ores of that north n are of necessity subjected, in ad- to the cost of concentration, leav- o provision for marketing, manager- d publicity expenses. Whereas, in ct to the mines operated under the gement of Mr. Holden—the Centen- Eureka, the Mammoth, Gold Roads other properties—we find the costs of mining alone to range well above, and in some instances double, the assumed recoverable values of the mines of the Alaska Gastineau company, which are the subject of this report.

However, all of this is immaterial in its bearing upon the flotation of the shares of the Alaska Gold Mines Company, because the subscribers to these shares are limited to a so-called clientelle of Hayden, Stone & Co., which is found in every community where mining shares are bought and sold. With them no inquiry and no concern is given to the intrinsic or probable value of such offerings, it being understood that parties receiving notice of the promotion of any new issue will be given an opportunity to unload upon others shares so acquired at advanced prices by means of a market which Hayden, Stone & Co. undertake and usually do provide by a process understood as "washed" sales and diligent advertising in a certain class of newspapers whose mining columns they seem to control.

But it is not these first subscribers in whom Mines and Methods is concerned—and clearly they need no counsel or advice from us—for at this writing, although yet four days from the date at which subscriptions will close under the announcement, "rights" to be acquired under the subscription are being bid for in the open market at an addition or premium of $1.50 a share, $5 paid. No one should suppose, however, that transactions of this character indicate real sales, but rather an early initiation of the "washing" process by which the real public investor is to be tempted into the coils.

The Hayden-Stone letter announces that "a large majority of these shares has been allotted to the group or gentlemen who will constitute the board of directors who have already been interested in the acquiring of these properties," but gives no information as to the terms or price or manner by which these gentlemen acquire the large controlling interest of the property, and herein lies the "joker"—the nigger in the wood pile—because no sane person, familiar with the business methods of Hayden, Stone & Co., or the habits of Messrs. Jackling and Holden, will believe for a moment that either of these gentlemen, the firm of Hayden, Stone & Co., or Mr. Charles Hayden, have invested or contemplate the actual investment of a single dollar in this undertaking.

To those who are sufficiently interested to watch the progress and development of this enterprise we predict: First, that by the time the shares are prepared for issue the price will be "washed" up to $10 or more, or a premium of $5 upon the original payment on the subscription price, and that shortly thereafter it will be discovered that an additional issue of shares will be necessary to provide a fund wherewith to acquire the outstanding share and bond interest, or debt, as the case may be, which will finally be found to have had provisional lodgment in the hands of the promoters of the enterprise. Second, this being taken care of, it will be discovered and announced, upon the authority of these great engineers that, upon further examination of the property and revision of the basis upon which original estimates of "possible," "probable," or "indicated" ore was made, that it will be imperative that the contemplated milling facilities be doubled or possibly trebled.

And so, step by step, will arise conditions requiring a constantly increasing issue of shares until the holdings of the promoters have been disposed of and the appetite of the investing and speculative world has been appeased, as was the case with Utah Copper, Bay Consolidated, Chino, and which is now being rapidly approached by the Butte & Superior.

PLAYING ON THE TREADWELL

The Salt Lake Tribune in its effort to support the Jackling-Holden-Hayden, Stone-Alaska gold flotation, as was its duty, in a recent issue quoted what purports to be a statement of average value of ore treated by the Alaska Treadwell over a series of years. The inference, in this case, as in the general presentation of the Alaska Gold Mines Company to the public, is intended to give the impression that the Alaska Gold Mines properties are an extension or continuation of the Alaska Treadwell lode. Unfortunately, however, for this assumption, the Treadwell mines are located on Douglas Island, whereas the Alaska Gold Mines properties are on the mainland, several miles distant and separated by the Gastineau channel.

It will be noted from the statement quoted by the Tribune that the value of the Treadwell ores run considerably over $2 per ton, whilst the "high-grade" ores of the Alaska Gold Mines are reported by Engineers Jackling and Holden as having an "indicated" value of $1.50 a ton. Now, it is quite possible that "indicated" values may not, in practical operation, yield as great a quantity of real gold as the actual values of the ores of the Treadwell mines, determined from the melting pot. Then, again, there is considerable difference between "indicated" values of $1.50 and real gold values of $2.00 to $2.45 recovered from the Treadwell. The rejected sands of the Treadwell ores, as we are reliably ad-

vised, contain less than 10c. a ton, which would indicate a recovery of about 96%, whilst an official report of the treatment of the Treadwell concentrates by cyanide gives a recovery of over 97%.

This suggests an average recovery from the Treadwell ores for the years mentioned in the Tribune article of $2.15 to $2.25. Applying the same rate of recovery to the Alaska Gold Mines ores seems to indicate an original value of about $1.60 a ton; but, the fact that this Alaska Gastineau is an entirely different ore deposit suggests the probability, at least, that its contents may not yield to the process of treatment in as high a proportion as that of the Treadwell ores, and this thought finds confirmation in the fact that for a number of years, three ore shoots comprising the richer portion of the Perseverance vein have been worked to a depth of nearly 1000 feet with apparently every facility that a liberal supply of English money and talent could procure, resulting in absolute failure of any profit whatever. On the contrary, in addition to the expenditure of several millions of dollars in machinery, the corporation now seems to be some millions in debt. Of course, the plant operated was not so large as that of the Treadwell or the smaller of the new phorphyry mines; nevertheless, it is just possible that in the mining and treatment of vein ores that the advantage of 6000 tons a day as against 1000 tons will hardly be sufficient to warrant the "indicated" net profit to be derived from the Perseverance of $37 500,000.

WHAT WOULD YOU SAY?

Editor Mines and Methods:

I buy your publication at the news stand and have gained lots of valuable information from it. A friend advised me to sell my interest in one of the best located business properties in this city, that pays 10% net and is increasing in value every year on account of location, and put the proceeds into certain (names of companies purposely omitted) mining stocks at around present prices. He suggested that I invest at least eight-tenths of the funds thus acquired in the stocks mentioned and stated that I would double my money before next Christmas—and I said "maybe." What is your honest opinion? It's next to impossible to get **actual facts** from any of the corporations and I am inclined to be more or less pessimistic—and since reading a few copies of your publication it looks to me as if I had better be **very cautious** or I will get some stocks that I cannot sell to advantage, let alone reap a big profit. Would you advise me to convert my 10% net interest in good, growing investment and hold proceeds for slump—big slump—in copper stocks during the next few months, and buy them outright, or do you think it wise to dabble in any stocks, mining or other kinds? Thanking you for any information you can give me on the situation, etc.

Mines and Methods continually receives communications similar to the one quoted—so many, in fact, that the task of making individual reply is altogether out of the question. We do not pretend to advise our readers as to the manner in which they shall invest their funds; neither are we sufficiently endowed with the power of clairvoyance to predict what may turn out to be good or bad investments. Could we do that with certainty we should soon "own the earth."

Within the last fifteen years or so the business of mining has so changed and the world has developed such a mania for gambling—"taking chances" is the less offense term—that the industry has opened a field to the talents of men possessed of magnetism and the faculty to read human nature, that has proven immeasurably profitable, and particularly to those who have graduated as past masters in the gentle art of stock market deception. Mining for precious metals has always carried with it a fascination possessed by no other calling and, with the rapid advance of mining and metallurgical science during the last twenty years, has sprung up an almost universal desire to reap the golden rewards that ownership in a "mine" has promised through the shrewd manipulators capable of creating a fever and then applying the "balm" in the shape of gilded slips of paper supposed to represent the buried wealth for which the purchaser is seeking and to secure which he is willing to stake his all. This country today contains hundreds of noted millionaires who are worse than "dead broke," millionaires who, were they compelled to make settlement and balance their accounts tomorrow, would find themselves so deeply involved that they could not extricate themselves in 100 years through legitimate effort. Most of these people came from the ranks of those who prospered in legitimate, unexciting avocations, but who could not resist the call to get into the "get-rich-quick" bespangled charıot of the modern mining promoter.

Under such conditions how would you answer questions like those propounded in the letter quoted above? What would you say to a man who tells you that he owns property that is constantly enhancing in value in a thriving city and from which he has a sure income of 10% per annum and who states that he is advised by "a friend" to sell out and buy half a dozen different kinds of mining stocks? Would you tell him the truth and say that possibly the "friend" had those very stocks for sale and that he was likely taking part in the final boom play in which all the "insiders" were working to unload? Or, would you be more circumspect and explain to him simply that mining is usually more or less of a speculation and that all mines deteriorate in intrinsic value in exact proportion to the rate at which the orebodies are depleted, and let it go at that? Or, again, if you

cared to be unusually frank, w
show that a property such as
paying 10%, is earning more th
of the so-called "legitimate" mi
did or ever can be expected to e
a world-beater like Utah Coppe
stance, (and granting, for the
argument, that its reports are t
is paying 5% on $60 a share, and
ery time a dividend is declared
the mine is worth just that much
that you would have to rece
dividend regularly for twenty
get your $60 back; and would
explain to him that, while h
something near what his city
holdings will be worth at the
twenty years, he could not gues
a mile of what he would hav
way of a tangible asset if he h
Copper for that length of time

You would not tell him that,
because it hurts the mining
All right, then, we won't tell him
we shall just let him go and
the problem to his own satisfact
if there are many other featu
should be considered in dealing
correspondent's queries.

HUMOR AND PATHO

"Why are you always telling
the matter with Utah mining
It's time the mines were coming
they need is a little boosting.
paper could do as much if not m
than the dailies because it hasn't
reputation of lauding everyth
comes down the line. People wh
believe what is said in it. Tell
the good things about the mine
will mail a hundred copies to eas
tomers who are especially p
about getting the straight of thi

The foregoing is what a loca
had to say to the writer of mi
financial "dope" for Goodwin's V
few days ago and it brought
couple of columns of pertinent a
taining comment from which th
ing choice morsels are culled:

A broker spoke and having sp
put his feet on the table and
back to watch the effect of his
argument, compliment and brib
compliment tasted fine; the bribe
ling; but the argument seemed
a screw loose somewhere. It di
together well. Restated it came

"People believe in your paper
it presents the risks as well as t
ises of Utah mining investmen
it. Give only one side of the sto
everybody. After awhile no one
lieve anything he sees in the p
I will have unloaded a choice lo
motion stock on your readers a
some money."

It is folly to talk of the mines
"coming back." They can't "con
because they have not been a
far as the mines are concerned o
fill pages every week in extolli
merits. * * * But there interv
tween the mines and the public t
cies for the control and transfer
ing stock. After these agenc
done their work a mine is not ne
a mine; it may be a prospect o
be a mere hole in the ground. T
may look exactly alike to the
who does not take notice that
twice as many shares of stock
ing as the other. And if nei
water in its stock one of them n

water in its shaft which depreciates its value by 50 per cent. One mine may be better than another of similar appearance because it has a more economical management, or because it is given better support on the stock exchange, or because it has a better smelting contract, or because it gets a lower freight rate. It is these differences that mean success or loss to the investor and anyone who urges the purchase of shares without calling attention to the elements which affect value is merely a capper for a brace gambling game.

* * * The dealers in mining securities have the best material to work with, but somewhere they are bungling the job. Possibly an association of mine owners and managers such as was proposed at the Commercial club meeting could do something to improve the situation. We have just had an example of the benefits of organization in this field. The Tintic Mine Owners' association, consisting of John Dern and Harry Joseph, sent a large and enthusiastic delegation (Mr. Dern is large and Mr. Joseph is enthusiastic) to Denver to see what could be done about the adjustment of the freight rate on zinc ore from Tintic to the Kansas and Oklahoma smelters which had been hanging fire for several weeks. The delegation called upon the traffic managers of the railroads at Denver and explained that through the oversight of the tariff makers the freight rate on zinc from Tintic was about $12 more than from other Utah points.

"Why, so it is! We never noticed that before," exclaimed the traffic managers. "Here, George, just cut a couple of dollars off that zinc tariff from Tintic. We'd make the new rate effective immediately only the Interstate Commerce commission requires 30 days' notice of a change of rates. Come again, gentlemen. G.ad to see you any time."

The committee of the whole of the Tintic Mine Owners' association put the matter up to the Interstate Commerce commission and by return mail received notice that the commission had waived the customary month's notice and would permit the new zinc rate to go into effect at once. The market price of May Day, which has about ten thousand tons of zinc ore blocked out, went up promptly two cents. Could there be a better argument for an organization of mine owners than this?

Messrs. Dern and Joseph might be incorporated as a Utah association if they had nothing else to do, but Mr. Dern has a half dozen companies to direct and Harry Joseph doesn't want to quit running for congress every few days to fix up a freight rate or interview a smelter. It breaks his stride. Moreover, an association, properly conducted, would require more work than the diligence of Dern or the energy of Joseph could compass. It would take a small staff to gather adequate statistics and to discover the many leaks through which profits are lost to the mining companies.

COPPERETTES

The senate committee on appropriations has added to the sundry civil bill $100,000 for the investigation of a method to prevent the enormous waste of minerals and to devise plans for treating low grade ores.—Mining Science.

The senate committee must have heard of the operations of the Utah Copper Company when it decided on the more mentioned in the above item.

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Steam shovel No. 257, a 91-ton shovel, working in the west borrow pit of the Gatun dam, at Panama, excavated 84,-315 cu.yd. of material during twenty-six [illegible] ys of May, or an average of [illegible] material per day. Of the [illegible] 259 cu.yd. were clas- [illegible] cu.yd. were classified as rock. This is the highest record for a month made by any steam shovel on the Isthmus since the beginning of operations.—Eng. and Mg. Journal item.

We'll just wager a cookey that the steam shovel reporter of the Utah Copper Company can make that Panama record appear insignificant by comparison; only that the character of the material handled probably would be classified as "prospective ore" and "near ore," in place of "earth" and "rock," the material moved at the Gatun dam.

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Constructing Engineer George O. Bradley, accompanied by Metallurgist Frank G. Janney of the Utah Copper, is inspecting the new mill plant of the Butte and Superior company. This concentrator has done its work very acceptably since it was commissioned, and Mr. Bradley has been complimented by metallurgists throughout the country for the manner in which he constructed and commissioned this plant in so short a time.—Salt Lake Telegram, Aug. 14.

Following this deserved compliment to the ability of Mr. Bradley, the same article goes on to say, in substance, that the mill will now be Janneyized according to the ideas of that eminent "metallurgist," so it may be taken for granted that the Butte and Superior plant will now be subjected to several years of "remodeling" along Utah Copper-Ray-Chino lines, when it is likely to be announced—as in the case of Utah Copper during the present month—that this will conclude the heavy expense of rebuilding and "leave only the enlargement of the crushing departments."

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Thompson, Towle & Co.'s "News Letter" of the 14th instant quotes "one of the best informed men in the United States on the copper situation" as follows:

"Consumers of copper in this country are loaded up with business. Every mill that I know of is working to its utmost capacity, having not only all the business it can take care of, but more than it can handle, and from what I can understand this condition is practically the same abroad. There is no longer competition between the mills, for they could not take any more business if same were offered and consequently all competition is eliminated."

And then, so as to show just how much sense there is in this "best informed" man's utterance, the Engineering & Mining Journal's "By the Way" editor takes him down the line in this fashion:

"It follows from this, of course, that if the manufacturers of copper are at 100 per cent capacity and can't take any more business, it is useless for the refineries to increase their output. It is satisfactory to have one fixed point from which to figure. This is a warning to the little mines, just starting up to get a piece of the pie, to keep out. Your copper is not wanted, consumption being already at 100 per cent of the possible."

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* * * It is known also that the United States company is continually on the search for new mines, and in charge of this department is Mr. Jennings. The company examines more mines in the United States, Alaska and Mexico annually than any other organization. * * An idea of the activity of the United States company in the search for new mines can be had from the recent annual report, in which Mr. Jennings told of having examined during the fiscal year 921 properties, of which only one was purchased during that period.—From an interview with A. F. Holden in Salt Lake Tribune Aug. 2, 1912.

The information contained in the above excerpts from the Tribune's interview with Mr. Holden awakens a few speculative thoughts. The first is why, (if the Alaska gold proposition which Mr. Holden, in conjunction with Mr. Jackling, has examined during the month and recommended to the public through Hayden, Stone & Co., was such a big thing), did not the United States company previously grab on to it? Then, it is simply marvelous to ponder over the activity and rapidity with which Mr. Sidney J. Jennings, vice-president of the United States company and in charge of its engineering department, examines mines for his company. He states that 921—nearly three a day, including Sundays—were examined by him during the past year and that only one was purchased. Mr. Jennings' speed in this line of work is probably without a parallel, unless it may have been shaded a little by Messrs. Jackling and Holden, when they passed upon the worth and "indicated" magnitude of the Alaska Gastineau properties for the new Alaska Gold Mines Co.

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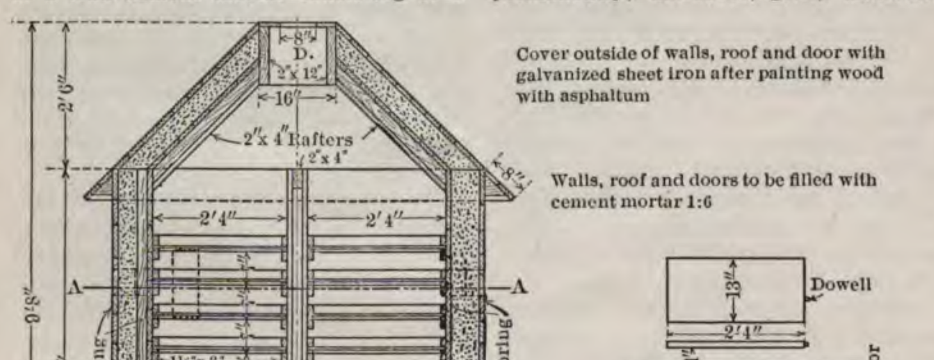
It has been suggested that the 313 Nissen stamps which formed the battery of the late Boston Consolidated mill—now more euphoniously dubbed the Arthur—would go a long ways toward the equipment of the new Alaska Gold Mines plant. Of course these stamps, though entirely successful on Boston Con. ores, under the management of the late Mr. Bettles, refused to work under the new name and were therefore unceremoniously blasted from their foundations. But possibly in that far-off northern atmosphere they may be found more subservient; this provided, of course, as to whether the Holden or the Jackling influence shall finally dominate in any possible metallurgy that may be involved in those ores.

MAGAZINES AND THAW HOUSES

"Magazines and Thaw Houses for Explosives" is the title of Technical Paper No. 18 recently issued by the United States Bureau of Mines. The authors, Clarence Hall and S. P. Howell present the advanced practice abroad and in the United States on the use of material for the construction of magazines and thaw houses and strongly recommend the use of a lean cement mortar consisting of 6 parts of sand and 1 part of cement as the material to be used in the walls, roof, and doors of these buildings in order that the explosives within them may be properly protected, also in order that life and adjacent property may not be jeopardized when magazines and thaw houses are constructed the proper distances from other buildings.



Sectional Views of Bureau of Mines Cement Mortar Thaw Houses.

In order that the explosives in magazines may be properly protected they must be guarded against bullets, fire, lightning, and unlawful entry. Different fireproof materials were experimented with to determine their resistance to the penetration of rifle bullets. Sand offered some advantages but was rejected because it would eventually flow out on the floor of the magazine through the cracks in the walls and could not be depended upon to remain in the structure permanently; moreover, gritty materials of any kind are objectionable on the floor of a magazine. Mineral wool overcame this objection but had little value as a medium for resisting the penetration of rifle bullets. Therefore, in order to overcome the objectionable features of sand, portland cement was mixed with it in order to form a lean cement mortar and thus enable the sand to be retained within the walls of the magazine, and still be friable enough to crumble readily under a blow. Tests to determine these two features were so satisfactory that a magazine having this cement mortar as a filling was constructed by the Bureau of Mines at a cost of $400 and having a capacity of 20,000 to 30,000 pounds. A working drawing showing the dimensions and necessary sections are included in the publication. The means provided for ventilation in the magazine of the Bureau of Mines has been found to be adequate, and, accordingly, the storage of explosives in respect to their keeping qualities is favorable.

The cement mortar construction is effective in resisting the penetration of rifle bullets and owing to its friable nature offers an additional advantage for the reason that, in the event of an explosion in or near the magazine, the large masses of material would not be projected over the surrounding country. The galvanized iron covering is fire resisting and at the same time it serves as an excellent medium for protection against lightning when the four corners of the building are properly grounded with metal rods.

The method of selecting a magazine site is emphasized and suggestions made. The permissible distance which must obtain between magazines and other structures in England, Prussia, Austria, Italy, Massachusetts, and also the proposed American table of distances are contained therein.

The proper method of thawing explosives in either small or large quantities and a suitable method of transporting them to the place where they are to be used is described in this technical paper.

A temperature not exceeding 90° F. is recommended in thawing explosives. In all cases explosives must be protected against moisture and high temperatures and for this reason thawing explosives by placing them before a fire or near a boiler or on steam pipes or by putting them in hot water is condemned.

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If you care to know just what is being done at the Chino and understand the situation, read James O. Clifford's article in this issue. The investor, if not the speculator, will appreciate it.

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Alexander N. Winchell has resigned from the United States Geological Survey in order to resume work as a consulting mining geologist. He has recently returned to his office in Madison, Wisconsin, after spending several weeks in Nevada in connection with litigation regarding the ownership of the remarkable ore deposits of the National mine in that state.

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Horn silver is the common name for cerargyrite.

Interesting Review Of Chino's Mines And Methods

By JAMES O. CLIFFORD.*

The mining properties of the Chino Copper Company are situated at Santa Rita, Grant County, New Mexico, about fifty miles north of Deming, New Mexico, on a branch line of the Atchison, Topeka & Santa Fe railroad. The average elevation of the Santa Rita district is 6500 feet above sea-level.

The total number of mining claims now owned by the company under patent right is 144, the total area thereof approximating 2650 acres; also, there is owned by the company 160 acres of patented land, acquired under agricultural entry, making the total area of lands owned at Santa Rita about 2810 acres. Surface rights only have been acquired covering a considerable area, thereby giving the company practically full control of all the desirable ground in the camp. Among the groups of mining properties acquired by Chino are the Whim Hill, Texas Flat, Montoya, Head, Lee, Romero-Santa Rita and Hearst-Carrasco, respectively, all of which are well known throughout the southwest for their record production of large tonnages of high grade copper ores—principally chalcocite and native copper.

Although officially included in the Central mining district, Santa Rita is distinct, geologically, from the region surrounding the town of Central. However, Santa Rita and Hanover (the latter place being about 2 miles northwest of the former, and separated from it by the low divide between Santa Rita and Hanover creeks, streams flowing south and southwest, respectively,) being in the same geological horizon are generally considered together and are commonly spoken of as the Hanover-Santa Rita mining district.

GENERAL GEOLOGY.

The geology of the Hanover-Santa Rita district is complex, the rocks comprising representatives of sedimentary, metamorphic, intrusive, and effusive types.

The sedimentary series consists chiefly of Devonian limestones and shales and carboniferous limestones having a total thickness of about 900 feet. The metamorphic rocks are sediments altered by porphyritic intrusions—contact-metamorphic rocks—and the old schists formed by regional metamorphism that represent the foundation of the sedimentary series.

The intrusive rocks comprise two porphyries; the first, a quartz-monzonite porphyry occurring as an elongated mass that has domed up the sedimentaries and then been partly exposed by their subsequent erosion, also cuts the sedimentaries in the form of dikes and irregular intrusive projections from the main body. The most noticeable constituents of this porphyry are dark biotite and hornblende, white and green feldspar, and quartz. The common result of alteration of this rock is the kaolinization of the feldspar, and the conversion of the hornblende and biotite into chlorite, epidote, and carbonate. Near the limestone it is locally much epidotized. This porphyry has caused profound alteration of the limetsones and is regarded as the original cause of mineral deposition in the district. The other intrusive rock is a quartz-diorite porphyry which occurs as dikes cutting the quartz-monzonite porphyry and the sedimentaries, some of the dikes being much sheeted parallel to their strike. The most noticeable constituents of this rock are plagioclase feldspar, biotite, quartz, hornblende, and magnetite, the latter in unusual development.

The effusive rock is represented by a reddish colored rhyolite which forms a mass of considerable size immediately southeast of Santa Rita, and is a remnant of the great flow which extends over a considerable area north of Hanover and Santa Rita.

A large block of Cambrian quartzite is found in the heart of the developed area in Santa Rita basin, and smaller masses immediately to the west and south. This quartzite is about 300 feet thick and occurs on the surface at the Romero mine. The schist found immediately underlying this quartzite at the 300-ft. level in the Santa Rita workings is several hundred feet in diameter and is regarded as the pre-Cambrian basement upon which the sedimentaries were deposited. The explanation of the presence of the Cambrian and pre-Cambrian rocks in Santa Rita basin is believed to be that masses of these rocks were torn off by the quartz-monzonite porphyry magma and forced with it up through part of the overlying sediments to the abnormal stratigraphic position they now occupy.

The limestones have been most affected by the contact-metamorphism of the intrusive porphyries; the quartzite is but slightly affected. The metamorphic zones in the limestones are similar to those in many other localities, but the action here seems to have been very intense, and the accession of mineral from the magmatic agents must have been great. Magnetite, pyrite, and zinc blende are locally developed in large quantities. The pyrite carries a little copper as chalcopyrite, and it is probable that the greater part of the copper that has been mined from this district originally existed in this disseminated state. It is evident therefore, that the contact-metamorphism of the limestone was of fundamental importance in the formation of the mineral deposits. The limestone is generally most altered at or near the

General View of Chino's Hurley Concentrator, Looking South.

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quartz-monzonite porphyry contact, but metamorphism has extended through at least 500 feet of the limestone strata, and laterally for much greater distances. The composition and physical character of the individual beds have largely determined the amount of alteration; that is, the degree of metamorphism does not gradually diminish away from the intrusive rock, but varies according to the position of the individual beds.

The quartz-monzonite porphyry is much jointed, especially in two directions approximately vertical and at right angles. The northeast system is somewhat more pronounced than the northwest. Many of the quartz-diorite dikes follow one or the other of these joint systems and have themselves been sheeted by later adjustment along the same plane.

ORE DEPOSITS.

The ore deposits of the Hanover-Santa Rita district are divided on the basis of origin into three groups—(1) vein deposits in quartzite and porphyry; (2) contact-metamorphic deposits occurring at or near the contact of limestone and porphyry, and (3) concentrations as the result of oxidation and transportation—deposits of secondary enrichment.

The principal ore deposits found at Santa Rita lie in an area about a mile square that is known as Santa Rita basin. The greater part of the copper that has been mined existed as the native metal, occurring principally in the quartzite, but also in the porphyry, especially in those portions much kaolinized. The native copper is found in the fractures of these rocks in pieces ranging in size from thin flakes up to slabs an inch or more thick and several feet square. The quartzite and porphyry are traveresd in all directions by these cracks, wherein there are zones or streaks or copper-bearing ground that can be followed for considerable distances. In some of the softer porphyry native copper is found as irregular grains and lumps surrounded by kaolin. The surface of these pieces of native copper is coated with more or less of the red oxide, cuprite, which is commonly crystalline. Much of the thinner scales of native copper have now been completely changed into cuprite. Close to the surface some of the oxide has been converted into the green carbonate, malachite, but at moderate depths it is present only as thin coatings, if at all. A little chrysocolla is present, and azurite occurs in little nests in the porphyry near the surface.

Next in importance to the native copper and cuprite is the cuprous sulphide, chalcocite, or copper glance. This mineral is confined almost entirely to the altered porphyry, but little of it having been found in the quartzite. The ore of this character that has been mined occured as stock-works and heavy impregnations of that mineral in the kaolinized and silicified porphyry.

General View of Santa Rita Steam Shoveling Operations; Romero-Santa Rita Main Shaft Hoisting Plant in Distance.

The principal bodies of native copper have been found in the uppermost 200-250 feet, and none have been found below the quartzite which is approximately 300-ft. thick. The workable lenses of chalcocite ore are confined to the uppermost 400 feet in the porphyry. For example, the Romeo shaft which was sunk to a depth of over 450 feet encountered little ore below the 400-ft. level. Similar conditions obtained at the other principal mines of the district. In this connection it is interesting to note that the largest single deposit of chalcocite ore found in the district was encountered in running a cross-cut from the Hearst shaft to connect with the 300-ft. levels of the Romero and Santa Rita shafts. This body of ore was approximately 200 ft. long by 60 ft. wide by 80 ft. high, and averaged throughout 10% copper per ton, although many carload shipments therefrom returned an average copper content of 36%. Similar occurrences are encountered from time to time in the other properties of the district, although they are small compared to the above mentioned deposit.

The principal ore deposits of Santa Rita basin seem to follow two well-defined channels of enrichment having respective strikes of northwest and northeast, following the contact of the quartz-diorite with the quartzite mass mentioned in a previous paragraph as occupying the central portion of the developed area of Santa Rita basin. These channels of enrichment seem to have their point of intersection near the Romero shaft. Extending in respective southwesterly and southeasterly directions from the Romero shaft along the channels mentioned small lenses of chalcocite ore, and seams of almost pure native copper are encountered. The ore occurrence referred to as having been encountered in the cross-cut from the 300-ft. leevl of the Hearst mine to a similar level of the Romero property is a representative occurrence of the ore bodies in question, although those at present being found are not by any means so large.

It is probable that the source of mineral forming the various types of deposits was the quartz-monzonite porphyry magma, and that while the deposits in limestone at the contact were formed at the time of the porphyry intrusion, the veins were formed later—after the rock had solidified and fractures had been developed.

The presence in the lenticular bodies of chalcocite of cores of pyrite, and aside from the ore bodies of masses of pyrite similar in distribution to the ore bodies, as well as in a more disseminated state, and all more or less coated with chalcocite, makes it certain that a great part of the cholcocite replaced and was precipitated by pyrite. There is no doubt that much of the native copper was derived by the oxidation of the sulphur of chalcocite, but no other explanation than deposition originally as sulphides offers itself, although it is evident that a considerable quantity of the native metal or oxide was not precipitated on pyrite, but was deposited from solution in open spaces in the quartzite, and as replacements in the porphyry.

There is no zone of leached ground overlying the ore bodies of sufficient thickness to have supplied the copper deposited below. On the other hand it is believed that the contact-metamorphosed limestone containing cupriferous sulphides that are present on several sides of Santa Rita basin, originally overlay the region of the present ore bodies, and that the copper they held was dissolved and finally precipitated in the underlying rocks.

scattered parts of the contact-metamorphosed limestone present on the several sides of Santa Rita basin enrichment has gone on chiefly in a portion of the original deposit itself.

CHINO ORE DEPOSIT.

The Chino ore deposit occurs in the form of a horse-shoe of mineralized quartz-diorite porphyry encircling a core of slightly altered quartzite. The mineralized quartz-diorite porphyry contains a variety of copper minerals; native copper, cuprite, and chalcocite however, predominating. The quartzite core is traversed by numerous seams of rich native copper ore. The seams of native copper, and the small lenses of high-grade chalcocite which permeate the mineralized zone have been found in those portions of the porphyry much kaolinized and in close proximity to the porphyry-quartzite contact.

A noticeable feature of the Chino deposit is observed in any of the deep workings of the older mining properties, the Hearst, Romero, Santa Rita, et al. With especial reference to the bodies of chalcocite ores found in the porphyry it is apparent that the central core of the deposit is almost pure copper glance, the values decreasing in value outward from the center. Similarly, as development progresses laterally from the enriched channels constituting the Chino deposit in its entirety, a marked impoverishment of the copper content is observable. This condition is responsible for the wide variation of the copper content of the ores developed and mined, and precludes any uniformity of the copper content within the entire developed area other than if only the enriched channels are mined uniformly. By the same token it will be noted that, as outlined under the caption 'Geology' there is a marked impoverishment of the ore content with increased depth, the reason therefor being given in an earlier paragraph.

PROSPECTING AND DEVELOPMENT.

The Chino ore deposit has been prospected and developed by churn-drilling operations, and underground mining methods respectively.

Churn-drilling operations ceased last January at which time approximately 500 holes aggregating 200,000 feet of drilling had been completed, the average depth of each hole having been 400 feet.

Underground development is still under way, extensive cross-cuts at present being run from the 100-ft. and 200-ft. levels of the Hearst-Carrasco and Romero-Santa Rita shafts. Incident to the underground development of these properties some high-grade ore is being shipped direct to the smeltery at El Paso, chiefly native copper.

The principle of drilling at Chino has been to sectionize the entire property area into 200-ft. squares, and to drill regularly on the corners thereof; or, where any uncertainty as to values was probable, the ground was drilled at more frequent intervals of space to fully demonstrate the facts. It is interesting to note in this connection that prior to the commencement of churn-drilling operations to effect delimitation of the ore deposit, there already had been fully developed by the underground workings of the older mining properties approximately 20,000,000 tons of disseminated ores, and partially developed about 7,000,000 tons.

Churn-drilling the Santa Rita district practically has been a failure. At best it is, even under the most favorable conditions, an imperfect means of delimiting ore deposits. Drill holes sunk even at intervals of 200 ft. distant do not afford assurance that all the intervening space is occupied by ore of commercial grade. Even tunnels and shafts, with their accompanying cross-cuts, which may have been driven in valuable ores at much shorter intervals of space may have been luckily or wisely directed along enriched channels, bordered by practically barren, or worthless ground. The physical character of the Santa Rita basin deposits precludes even fairly accurate results from churn-drill prospecting. To say the least it is extremely difficult to accurately sample the ores encountered through the underground workings.

The tonnage of ore developed to date by churn-drilling operations and underground mining methods is officially stated as approximately 55,000,000 tons, said to contain an average content of 2.21% copper per ton. Of this tonnage it may be safely stated that at least 60% was developed by underground methods.

The average thickness of the Chino ore deposit is approximately 110 feet, capped by an average overburden of 095 feet, or if due allowance as overburden is made for the so-called oxidized ores that are removed and placed in stock for future use, 110 feet.

The average cost of steam-shoveling is officially given at 31.68 cents per yard of material removed. Therefore, if we assume a ratio of 1:1 of overburden to ore, the cost per ton of ore mined will be 31.68 cents.

At the present time steam-shoveling operations, insofar as ore shipments are concerned, are being confined principally to the Romero, Whim Hill, and Hearst-Carrasco pits. Of particular interest in this connection is the fact that operations are chiefly along the lines of the enriched channels extending from the Romero main shaft. The average grade of ore from this section ranges from 2.592% to 3.18% copper per ton, and in some instances higher, and it is ore of approximately this average grade that at present is being sent to Hurley for treatment. In general it seems to be Chino's plan to mine its richest ore reserves first as evidenced by the proximity to which it works in toward the older workings of the mines that have produced high grade ores.

There are parts of the Chino properties which cannot under any reasonable circumstances be steam-shoveled, and, in view of the extensive underground development which existed previous to the beginning of actual mining operations it seems reasonable to believe that under the then existing conditions that underground mining methods should have been given preference over steam-shoveling. However, it is quite probable that in the near future the percentage of ores mined by underground methods will, relatively, be greater than the tonnage supplied by steam-shoveling.

CHINO MILL AT HURLEY.

The total area of property owned and controlled at Hurley and in that vicinity for millsite purposes and in connection with water rights is approximately 7200 acres, of which total 700 acres are leased from the State and individuals, the area directly owned by the company being 6500 acres. Hurley is about nine miles south of Santa Rita on the Whitewater-Santa Rita branch of the Santa Fe railroad. The Chino concentrator is about three-quarters of a mile east of the railroad depot and on the west bank of Whitewater creek.

Power Plant.—Steam is generated by eight 500-h. p. Heine water-tube boilers set in batteries of two, 180 lbs. steam-pressure being the normal working load. Green chain-grate stokers are used exclusively for automatic firing, and feed water is supplied by three compound duplex Wheeler pumps equipped with feed water heaters. Green suction ash-handling system for the removal of ashes has been installed recently. The water from the engine condensing system is delivered to two cooling towers over the 3,000,000-gallon concrete storage reservoir.

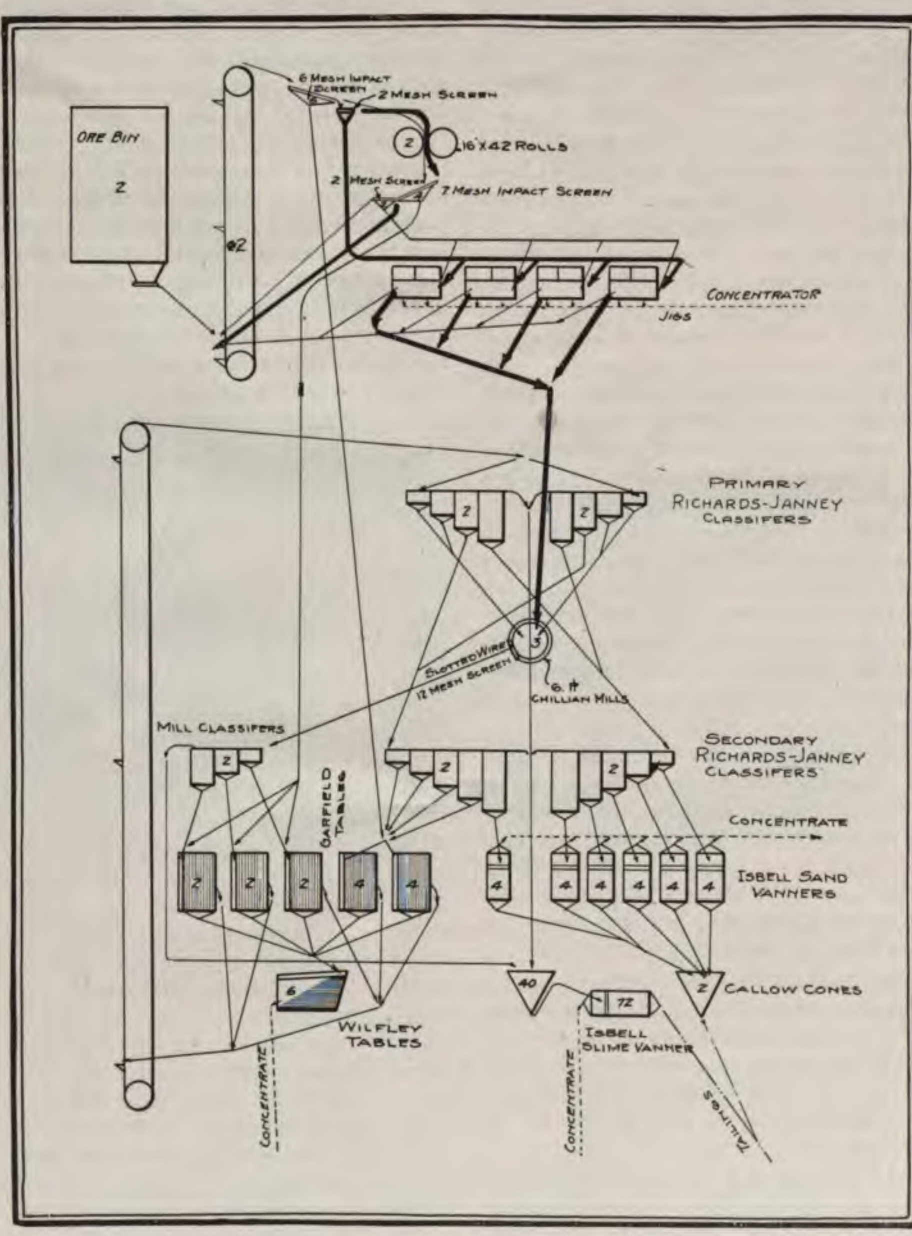
The equipment of the electrical generating plant consists of three-Nordberg-Corliss cross-compound engines operating at 100 r. p. m. These engines have 28 in. high pressure and 60 in. low pressure cylinders with a common stroke of 48 ins. The generators are of Allis-Chalmers 3-phase, 60 cycle type, generating at 480 volts, direct mounted on the engine crank shaft, the nominal rating of each generator being 1250 k. w. Power is transmitted to the Santa Rita mines and the several pumping stations at 24,000 volts, step down transformers to 480 volts be-

ing provided at the several sub-stations for the various points in use.

Water is obtained from four pumping stations as follows: Apache Tejo, four miles south of Hurley, equipped with two Aldrich quintiple-geared electric-driven pumps—one pump being held in reserve for emergency use; Whiskey creek, four miles northwest of Hurley; Cameron creek, one mile north of Whiskey creek; and B ranch, one mile northeast of the concentrator in Whitewater creek, the three last mentioned stations each being equipped with one Aldrich triplex-geared electric-driven pump.

CONCENTRATOR.

The crude ore bins, having a capacity of 15,000 tons of ore, and the coarse-crushing plant, having a capacity of 450 tons per hour, form one structure. The crude-ore bins are equipped with two standard guage railroad tracks above, and two separate lines of conveyor belts beneath, the latter fed by automatic caterpillar ore-feeders. The coarse-crushing plant consists of one No. 8 McCully gyratory crusher and one set 20 in. x 72 in. Garfield rolls. The coarse-crushing plant is connected by an inclined belt-conveyor, 265 ft. long between centers, to the main mill building containing the fine-ore bins.



Flow Sheet of Chino Mill—Light Lines Show Present Arrangement. Heavy Lines Show Previous Arrangement of Jigs.

The fine-ore bins are circular steel tanks, each bin having a normal capacity of 1,000 tons, equipped with automatic caterpillar feeders and necessary belt conveyors. At the head of the inclined belt-conveyor delivering from the coarse-crushing department to the fine-ore bins is an automatic sampler for taking the head sample.

At present the concentrator comprises five units having a normal daily capacity of 1000 tons per unit. Three of the units are in operation; a fourth will be placed in commission September 1st, and the fifth about November 15th.

Flow Sheet.—From the coarse ore bins the mine-run ore is delivered by belt-conveyors to a bar grizzly of 1 in. spacing, the undersize going to the inclined belt-conveyor for delivery to the fine-ore bins, and the over-size passing through the No. 8 McCully gyratory crusher to pass a 2¼-in. ring. This crushed material is then elevated by a vertical bucket-conveyor to another bar grizzly of 1 in. spacing, the undersize going to the fine-ore bins, and the oversize going through the 20 in. by 72 in. rolls being reduced to pass ¾-in. ring. This material is dropped immediately upon a 1 in. screen grizzly the over-size going to the bucket conveyor, and the undersize to the fine-ore bins. The crushed ore, therefore, has a maximum size of approximately 1 in.

The fine-ore bins deliver the ore to two vertical bucket-elevators which in turn deliver at the top of the mill to six 6-mesh impact screens. The oversize from these screens goes through two 16x42-in. Garfield rolls, the undersize going to the first eight Garfield 'roughing' tables. The rolls product passes over four 7-mesh impact screens, the undersize from which is sent to the second series of six Garfield 'roughing' tables, and the oversize is immediately passed over a 2-mesh screen, the undersize from which is directly delivered to four 'bull' jigs, and the oversize returned to the bucket-elevator pit.

The first and second series of Garfield 'roughing' tables, a total of 14 tables deliver a head product to 6 Wilfley tables, the latter yielding a concentrate. The middling and tailing from both sets of tables are sent to a third bucket-elevator which delivers the product to four primary 4-spigot Richards-Janney classifiers. The sizes from spigots 1 and 2 of these classifiers are sent to the feed tanks supplying three Chilian mills. The third spigot product of the primary classifiers goes to two 5-spigot Richards-Janney classifiers. The sizes from spigots 1 and 2 of these classifiers are sent to the feed tanks supplying three Chilian mills. The third spigot product of the primary classifiers goes to two 5-spigot Richards-Janney classifiers, the fourth spigot of the primary classifiers being delivered to the other set of two secondary 5-spigot Richards-Janney classifiers.

The product of the first four spigots of the set of secondary classifiers treating the third spigot product of the primary classifiers is sent to the first series of

Garfield tables. The fifth spigot
t going to one set of Isbell sand
rs. The two secondary 5-spigot
iers treating the fourth spigot pro-
f the primary classifiers serve five
te groups of Isbell sand vanners.
re-ground material from the first
cond spigots of the primary classi-
educed in the Chilian mills to pass
h, goes to two 3-spigot Richards-
r mill classifiers. Each of the
of these classifiers deliver to
le groups of the second series of
d tables.
overflow from all the classifiers is
mily delivered to 40 Callow cones
-watering, the thickened pulp
rom being treated on 72 Isbell
vanners.
first true tailing product of the
circuit is made by the group of
ell sand vanners, the tailing from
is sent to two large Callow cones
watering in so far as possible.

nsistent Methods.—It is quite evi-
from a general review of Chino
practice that there are many in-
encies in the treatment of its ores.
ample, the two 3-spigot mill classi-
ridence a purpose of classifying the
mill product and delivering dif-
sizes to three different groups of
d tables. However, it will be not-
t this attempt at classifying is off-
the direct mixing of the under-
om the second set of 7-mesh im-
creens with the classified material
he mill classifiers on the Garfield
In this connection if Chino con-
tes the treatment of an unclassi-
lp on the Garfield tables the mill
ers are, in the main, an unneces-
djunct. On the other hand if a
ed pulp is desired it seems rea-
e to believe that the 7-mesh im-
creen product should be diverted
e mill classifiers. In the absence
ore definite excuse for this appar-
glect of an important milling prob-
is quite probable that Chino real-
e unusual sliming of its ores re-
from the abrasive action of the
mills and consequently desires to
te the slime at the earliest prac-
stage, although even in the ab-
of the mill classifiers it could as
ally be removed by the primary
condary classifiers.
special interest is the installation
attery of four 'bull' jigs to each
f the mill, which evidently was
ntemplated in the original mill
The several important changes that
een made in placing the jigs at
wherein it was assumed the max-
efficiency thereof would be ob-
is clearly outlined in the diagram-
flow-sheet plan herewith given. In
st instance (that is, the initial operation of the mill) the undersize from the upper impact screens, which at that time were approximately 4-mesh, was sent direct to the Chilian mills.

Later the jigs were installed between the primary and secondary classifiers and the oversize from the first six 4-mesh impact screens in lieu of being sent directly through the 16x42 in. Garfield crusher was first passed over a 2-mesh screen, the undersize from which was sent to the jigs, and the oversize then to the rolls. The tailing from the jigs was then delivered to the Chilian mills for further regrinding. That arrangement proving unsatisfactory, the jigs were removed to the position which they now occupy immediately beneath the 16x42 in rolls, and the 2-mesh screen from its place near the upper 6-mesh impact screens removed from their former position and so placed that the oversize from the second set of 7-mesh impact screens is immediately dropped thereon, the undersize going to the jigs, and the oversize to the bucket-elevator pit. As now arranged the jig tailing goes direct to the bucket-elevator pit, and in view of change outlined the fine-crushing department has been changed from dry to wet service.

Primarily the reason for jig installation is the removal of the coarser native copper which commonly occurs in the Santa Rita ore deposits and reference to which has been made under an earlier heading.

Operating on Richest Ores.—With three of its five units of the mill in operation Chino is treating approximately 3900 tons of ore daily. While the normal capacity of each unit is rated at 1000 tons per day, as much as 4100 tons has been known to be handled by the three units in about 24 hours on several occasions.

The ores which have been milled, and at present are being milled, are mined chiefly from the enriched channels bordering the Whim Hill, Hearst-Carasco, and Romero-Santa Rita fissures, and commonly known as the Whim Hill, Romero, and Hearst steam-shovel pits, respectively. The physical character of the different ores from those sections are subject to wide variations in structure and copper content evidenced by the lack of uniform distribution as outlined in the description of geological conditions in a previous paragraph. Consequently the average grade of ore treated, and the relative percentage recovery, will be subject to constant fluctuation.

While the average copper content of the Chino ores is officially stated at 2.21% per ton, it is interesting to note that the grade of ore treated at the mill to date has been derived from the enriched ore channels mentioned in an earlier paragraph, (commonly termed respectively Romeo, Whim Hill, and Hearst steam-shovel pits,) the average copper content ranging from 2.592% to 3.183%, and in some instances even higher.

Maximum percentage recovery of copper is sacrificed to tonnage treatment of material, with the consequent result that extraction at the Hurley plant never has been greater than 58% of the copper content of its highest grade ores, and, of the copper recovered, at least 60% represented the native metal and cuprite.

Water Shortage and Copper Costs.—Chino is short on water notwithstanding its four pumping stations. There never has been sufficient water to supply the first three units for any considerable period of time. So that sufficient water might be recovered from the three units now in operation to care for the two additional units which will shortly be placed in commission, first the sand vanner tailing was subjected to de-watering in so far as practicable, and, recently, an elaborate system of wooden settling tanks comprising thirty rectangular sections each approximately 20x18x8 ft. The tail race from the mill empties into this series of tanks, and the recovered water is returned to the storage reservoir. It is stated by those who are in position to know that this latest improvement will effect recovery of 67% of the total water used by the first three units of the concentrator, a quantity of water exactly sufficient to supply units four and five when they are placed in operation. However, in order that a permanent water supply will be assured the company contemplates the construction of a large concrete dam in one of the mountain draws near Hurley to impound the annual flood waters of a portion of the Santa Rita watershed. If this last mentioned project proves successful it is the intention of the management to increase the capacity of the Hurley concentrator to eight, and possibly to ten units; also, to construct and operate its own smeltery at Hurley.

Official reports state the cost of copper production at less than eight cents per pound, with a probable reduction in cost to less than seven cents. Those production costs that have to date been stated as seven to eight cents per pound, respectively, are grossly misleading, for the special reason that only the approximate mining and milling costs are included, omitting the important factors of prospecting costs; expense stripping ore deposit of overburden; amortization of plants; smelting, refining and marketing charges. It is quite apparent, therefore, that the major percentage of production cost is carired as deferred payments, or charged to capital account. Under the most favorable conditions Chino has

never produced copper at a cost less than 11.034 cents per pound net, an allowance of 2.115 cents per pound having been made for contained gold and silver.

CONCLUSION.

Chino is unquestionably the best of all the southwestern 'porphyries'. In fact the Hanover-Santa Rita district in its entirety is one of the best known copper producing sections in the southwest, as evidenced by the extensive holdings of the Phelps-Dodge Company, Calumet & Arizona and other large interests, although practically only the Chino is actively operating at present.

The coming year will witness several marked changes in the mining and milling practice of Chino, which it is hoped will be for more rational mining methods, and greater efficiency of its milling practice, which at this time is deplorable.

MINERAL DEVELOPMENT SOUTH OF CANAL ZONE

By C. F. Z. CARACRISTI*

The approaching completion of the Panama canal will stimulate the early development of an empire of mineral and agricultural wealth in South and Central America. The expansion of these industries is usually in proportion to the necessities of mankind rather than the outcome of purely sentimental or premature financial efforts. No industry can be successfully promoted and maintained upon a sound basis that has not as a surrounding quality the demands of pure necessity. The increase of the world's population, attended with the demands of mankind upon nature's storehouses, will shortly force industrial progress in remote regions, that but a few years ago were neglected.

The Panama canal will shortly bring into the path of progress the countries of Costa Rica, Panama, Colombia and Ecuador.

In years past the development of tropical countries has been somewhat impeded by the fear of yellow fever and other diseases peculiar to these countries. This impediment, however, has been almost removed by the work of Dr. Rudolph Ezdorf and Col. Gorgas, who, by scientific investigation and a campaign against these diseases have given to the world more territory than Columbus. They have made possible the development of regions which in years past have been but pest holes on the face of the earth. The conquest of the fever bearing mosquito and the system of tropical sanitation, due to American science and American energy, has given mankind vast future possibilities and reclaimed areas so great that the mind can hardly conceive of their importance. Had the war with Spain brought about no other result, this achievement alone would have well repaid the great sacrifice of life that this war cost the American people. The work of these American doctors has made it possible for the white man and his posterity to lay claim to tropical America and Africa. It has made the Panama canal possible and given a new impetus to the development of unlimited tropical resources. The Isthmian canal and the sanitation of the tropics are no longer dreams. The canal will bring the whole world in touch with equatorial America and the knowledge that the miasmic pestilences of the past need no longer be feared, will promote the energetic development of the fertile country and rich mines that surround the interoceanic water-way. In Costa Rica, Colombia, Panama, and Ecuador alone there are 580 million acres of land capable of supporting a population of over 15,000,000 people.

But we must increase our detailed knowledge of the possibilities of these countries and it is the duty of the countries themselves to aid in the work of promoting their national welfare. Hundreds of millions of acres of fertile lands are found in Costa Rica, Panama, Colombia and Ecuador that are subject to the influence of the Isthmian canal, but our knowledge of the region is so nebulous and vague, that we know of it only in a general way from hearsay from some more or less responsible spirits who have entered the region in search of wealth or adventure. Little if any scientific work has been systematically practiced and even the best known sections lack that fund of information that is required to induce capital to venture its ever fickle expansion into the "terra incognita" of tropical America.

GEOLOGICAL SURVEYS NEEDED.

Some years ago after making an examination of the mineral resources of Colombia, a part of Venezuela and Ecuador, I discussed the establishment of a temporary geological survey with President Ricardo Jimenez of Costa Rica and this progressive and able exec considering this project when rible earthquake devastated hi and depleted the national treas establishment of geological s these countries will do much drawing attention to their g eral wealth and the attraction for its development.

There is a highly interestin that extends from the Nicaragu ary to a point some forty mil the volcano of Chiriqui or Var ama. Taking this volcano as and drawing a circle with a radius a country of great mi agricultural wealth is to be fou gives promise of great future ment. The country away fron board is high and healthful, ric erals, with fertile soil and goo and ample water. It must som come the abode of an importa and industries. Both on the sea and the Pacific ocean a spaceous bays and harbors. A kind of lignite is found in t that contains over 66 per cen bustable gas and may be subst cannel coal in the manufactur minating and producer gas fo combustion engines. Some cop silver and lead have been fou region but no important eff been made to work any of the pecting is difficult owing to t soil overburden and the rank the tropics.

This fact is true of all torrid In fact I have located mineral and after three months absence find the outcroppings. Further Panama, between Porto Bello territory occupied by the San dians, manganese, iron and me found. To me the mercury ha been a source of wonder becau been invariably found in the state in rock cavities after r cinnabar was encountered, but that future exploration near t sive dikes and the thermal sprin Isthmus, vast deposits will be believe that the phenomenon c metalic mercury, in lieu of the is due to the breaking down o phide by heat action, the rains it out and depositing it in basin by erosion.

At the southeast end of Pan also across the border in Colc the Isthmus of Darien, in the occupied by the Occidental Ind in the Isthmian Andes are fou silver and copper.

WHERE INTEREST CENT

But of more intimate interes world's progress is that part of

*Civil and Mining Engineer of Mexico City, in Mexican Mining Journal.

that forms the northwestern extremity of the South American continent, that stretch of territory that is encompassed between the Rio Atrato forming a north and south boundary on the east and the Pacific ocean on the west. This is the noted Choco country—the land of gold and platinum. It is platinum that today attracts the attention of the industrial world. The prohibitive price that this precious metal has reached commands the serious attention of the electrical world. The solution of the platinum problem rests with the placer beds of Choco. Some more systematic method of washing must be found; the work must be carried on by more important efforts than the dissolute and haphazard will of Indian and native negro labor. The world's demand for platinum should stimulate a more complete study of the Choco region. Washing in the Choco belt in the dry season (it is practically impossible to work during the rainy season) should be carried on by the use of artesian well water, which may be had in many sections. From what I have seen of the Choco belt during the dry season, when water is low and unavailable at points where the gold-platinum bearing drifts are found, the only solution is the possibility of the use of artesian well water. The platinum bearing placer beds, while in an aggregate covering an extensive area, do not at any place possess sufficient local extension to warrant the expenditure incidental to the installation of expensive flumes, etc. Nearly all of the region has been metamorphosed by excessive local ingenous influences so much so that one needs not to be a geologist to note the weird peculiarity of that part of the landscape when the rocks are exposed to view.

East of the Choco and of the Rio Atrato, on the rios Leon and Sucio, in the country that lies between the Gulf of Darien and the Rio Mulato in the extension of the Abibe mountains, coal, petroleum, copper, iron, lead and silver are found. Here, too, are lands that have no superior in the way of fertility anywhere on earth. These lands are accessable to good harborage. Here is a land practically uninhabited that has ideal surroundings and only awaits the man of brain and energy to convert them into a proftiable domain.

The treatment of Colombia by the United States over the Panama canal, unless that country will consent to the arbitration of the dispute by the Hague tribunal, a request that is only just and which the American government should do everything to promote, has temporarily at least created an adverse feeling towards Americans, but has not developed any adverse acts of personal resentment. The Colombian people realize that the masses of the American people are not responsible for the vagaries of an ex-president and for that reason citizens of the United States are not disturbed in any way in the enjoyment of their justly acquired rights.

PETROLEUM IN ABUNDANCE.

Along the Colombian coast, on the costal plains and the maritime Andes are found petroleum in abundance. On the rios Zulia and Catacumbo in Venazuela, just south of the great lake of Maracaibo are also found extensive petroleum fields that should attract attention and development. It is doubtful if the coal fields of the coastal plains, especially those southwest of the city of Rio Hacha in Magdalena will ever be worked profitably, because of the grade of the coal itself the great amount of water that the mines will encounter with depth, the softness of the hanging walls and the heat that is developed near the equator with depth and the difficulty of ventilating the mines.

In Colombia, also, the proper prospecting of the Sierra Nevada de Santa Marta should present scope for mineral development.

The interior of Colombia presents a vast field for future development when the railway facilities are to be had for getting into this country, and when the canal is completed and the proposed inter-continental railway, the dream of the late Hinton R. Helper, who projected the idea before a convention in the city of St. Louis in 1848, becomes an accomplished fact.

In Ecuador the most attractive field today, that is presentable to foreign investment seems to be the oil fields of the region surrounding the bay of Santa Helena. Oil, sulphur and rock salt are found here in abundance on the Pacific costal plains.

But the two points that seems to have the greatest present advantage are those localities found on both sides of the border of Costa Rica and Panama and the country that lies in the Caribbean Andes and their spurs, from Rio Atrato to the Great Lake of Maracaibo.

On the coast of Boajira peninsula, in Colombia I examined pearl and sponge beds equal to those of Panama; while the fisheries of the Colombian coast cannot be surpassed anywhere.

The present government of Colombia presents every outlook for a peaceful stability. It is headed by men of energy and integrity, combined with that personal force of character that is required to govern a people who have inherited from the Spanish conquerors a love for war and deeds of martial valor.

Everyone who knows him at all will believe that President Carlos E. Restropo will make Colombia the greatest of all countries of northern South Africa. He is a man of learning, honest to a fault, slow to act in diplomatic matters without first accepting the best of advice; but with it all he is a man of vigorous energy who well deserves the hearty support of the Colombian people and the respect of foreign powers. I believe that President Restropo will regenerate Colombia and bring out all of the dormant good and riches that now only await the confidence of foreign capital to make them a factor of importance in the wealth of the nations.

While I cannot fail to condemn the action of President Roosevelt and the American government in its treatment of Colombia in the sham war of Panama and the methods of acquiring the Isthmian canal concessions; yet I can see in the realization of an interoceanic canal the future up building of Colombia as a nation of the first importance, through the incoming of foreign capital and the development of its vast resources.

While American dollars may look upon Latin America as their inherited right, there is something more powerful than wealth to be considered in international relations. We must command the hearty respect of our neighbors, which mere money cannot purchase. The sooner that the claims of Colombia are recognized by the United States, the better for us all.

A new apparatus, simple of construction and easily workable has been thoroughly tested at the testing shaft of the Prussian Mining Department, for the purpose of signaling from cages in motion. The results are said to be very satisfactory. The shaft is 420 meters deep, the usual ascending or descending speed of the cages is 6 m. per second and for the testing purposes the speed was increased to 7 m. per second and the apparatus was found to be absolutely reliable and signals can be given at any time from the moving cages. The bridging over of the plats and intermediate levels by the contact lines does not present any difficulty. The apparatus is also provided with a telephone, which by the application of a very simple device can, in cases of emergency, be used for telephoning from the moving cages.

The appearance of a raw clay is no criterion whatever as to the color of the burned product. The colors of clay vary widely, from the white of kayolin to the dark red, or black, of the red burning clays. The main coloring constituent of clays is iron oxide, and according to the amount present it gives colors ranging from buff to red.

LEACHING APPLIED TO COPPER ORE* (XXI)

COST OF ELECTROLYTIC EXTRACTION OF COPPER FROM ITS ORE (CONTINUED)

By W. L. AUSTIN.†

An example of the application of ferric chloride as a chlorine conveyor in the lixiviation of copper ore is found in the Baker-Smith process, described in U. S. patent No. 843,986, dated Feb. 12th, 1907. The characteristic features of this leaching method are: the bringing of fresh chlorine into contact with the ore continuously during lixiviation, and its adaptability to unroasted material. It differs from other processes employing ferric chloride as lixiviant, (wherein a batch of ore is treated with a solution which is constantly diminishing in strength), by the method of continually applying fresh chlorine. Naturally, unless the strength of a lixiviant is maintained toward the end of the operation the solvent action must be weakened. In the Baker-Smith process a strong solution of ferric chloride is agitated with ore, and as fast as it is reduced to ferrous chloride it is withdrawn from the vat and recharged with chlorine. The advantage of such a mode of procedure is that one is working with a strong lixiviant up to the time that extraction of the metal has been completed. By this method the chlorine is continuously raising ferrous chloride to ferric, and in consequence that powerful reagent is only transferred to those substances which reduce ferric chloride, such as metallic sulphides. The presence of much ferrous chloride prevents the escape of chlorine gas, and it is not wasted by entering into useless combinations.

Metallic sulphides are attacked by ferric chloride, the metal going into solution and sulphur being liberated. If chlorine were applied direct to the ore, the chlorine would combine with separated sulphur, forming chlorides of sulphur, which would consume the reagent to no purpose. Sulphur chlorides are decomposed by water, yielding hydrochloric acid, sulphurous acid, and sulphur. This is avoided in the Baker-Smith process by [illegible] the [illegible] apparatus. Sulphur separated from the ore by [illegible] the copper sulphide. [illegible]

sodium, calcium and magnesium are not desired in the lixiviant as they are said to interfere with the recovery of any zinc the ore may contain. The inventors of the process are ambitious, for they aim to recover copper, lead, zinc, manganese, silver, gold, and sulphur from mixed sulphide ore.

A lixiviant of from 1.2 to 1.5 specific gravity, containing two grams metallic iron per litre, is recommended by Baker and Smith, and the pulp is heated by live steam. The ore is ground and put through screens ranging from 16 to 40 meshes to the linear inch. The patent specifications are very full and show that much thought has been bestowed on the subject. The theory involved in the process is sound; but it would seem as though the apparatus advocated, and the mechanical manipulation suggested in the specifications, might be improved.

Applying the Baker-Smith process to ore containing: copper, 2.76 percent; silica, 46.0%; alumina, 8.2%; iron, 12.4%; calcium oxide, 4.7%; and sulphur 11.6%, the weight of chlorine necessary to decompose the copper sulphide would be theoretically 61.5 pounds for 100 percent extraction. At $0.025 per pound the cost of the chlorine used as lixiviant would be $1.54, or $0.027 per pound copper. Some chlorine in addition to that used in dissolving copper would be consumed in forming combinations with other ingredients of the ore, and some would be lost through adhering to the tailings. On the other hand, if the lixivium is electrolyzed in recovering the copper, most of the chlorine combined with that metal would be set free, and could be used over again. The actual consumption of chlorine would then be confined to an excess of ferrous chloride formed, which might have to go to waste, and to loss in the tailings. If the leaching department is charged with chlorine used in bringing copper into solution, then the cost of electrolytic deposition of the metal could not be included in the [illegible]. So that in a process where chlorine is [illegible] in the manner described, the expense of [illegible] deposition would [illegible] somewhere between [illegible] cents per pound copper [illegible]

covered, and the cost of lixiviant would be practically nil.

PRECIPITATION BY IRON

The next item to be considered in the cost of leaching is deposition of the metals from the lixivium. If iron is used to throw down copper, the expense will be the cost of anywhere from one to three pounds of metallic iron, (according to the skill of the metallurgist), to one pound copper obtained in the form of precipitate. To this must be added the expense of reducing the precipitate to merchantable metal.

Precipitate, (to which the name of cement-copper is often applied), is generally a mixture of metallic copper with basic iron-salts, particles of ore, pieces of iron, graphite, silica, some antimony and arsenic, ferric arsenate, etc. The copper content naturally varies greatly. Precipitate resulting from treatment of mine-waters is generally purer than that produced from liquors derived from artificial leaching. This is partly because natural waters carry free sulphuric acid, and therefore deposit less basic salts which interfere with the subsequent refining, and those which do form are carried away by the current.

Because of impurities associated with precipitated copper, this substance is usually subjected to a mechanical treatment—washing and screening. If chlorides are left in the mixture, they occasion a loss of copper in the furnaces; but if the precipitate is bricked with lime as a binder, any chlorine present is rendered innocuous. To remove pieces of metallic iron, the raw precipitate is washed through screens with holes about one-eighth inch diameter, the iron-scrap remaining on the screen. Material passing through the screen may be washed on concentrating tables to remove the basic salts. An alternative plan has been to wash in a revolving screen under water, and in some instances the fines have been passed through launders which gradually increased in size so as to give the heavier particles an opportunity to settle out.

At some German works three products were made by mechanical treatment: (1) [illegible] copper; (2) [illegible] copper; and ([illegible]

slimes—content 20 to 25 per cent copper. At Duisbourg and Hemixen the precipitate was washed on a grating composed of copper bars. All but the large pieces of copper, and iron fragments, passed through, collecting in a vat below. This vat had the form of a series of steps; the best copper collected on the upper steps—impurer metal on those lying lower. The fines were then carried to a series of planes, where further quantities of copper were separated: tne fines contained most of the arsenic. The cement-copper (70 to 80 percent metallic copper) was placed on a draining-floor, and afterwards was dried on heated plates. Sometimes cement-copper has been bricked to prevent oxidation, for it oxidizes very rap!dly when exposed to the air; if it is desired to preserve it as such, it should be kept under water.

According to C. H. Jones, (Transactions of the American Institute of Mining Engineers, Vol. XXXV, pages 9 to 10), at Rio Tinto the crude precipitate is thrown upon a perforated copper plate, and is then washed through the plate and down a long launder. Leaf-copper and pieces of iron remain on the plate, and the precipitate passing through is concentrated by repeatedly turning over against the current. A red mass, containing 94 percent copper and less than 0.3 percent arsenic, collects in the first few yards of the launder. Further along the material carries 92 percent copper and between 0.3 and 0.75 percent arsenic: below this settles a very fine material carrying on the average 50 percent copper and 5 percent arsenic, all the graphite from the pig-iron used in precipitation, and the greater part of the antimony and bismuth. The first two classes are dried and bagged: the third is moistened with acid liquors, made into balls and dried in the sun. It is smelted to matte, and the matte is blown to crude-copper, in which operation arsenic, antimony, and bismuth are said to be removed.

SMELTING THE PRECIPITATE

A similar method of treatment has been used elsewhere, for it was discovered at several works that smelting impure precipitate to matte was preferable to making black-copper. Simply smelting and refining was found to yield an unsatisfactory product, because of the presence of basic sulphates, arsenic and antimony. In smelting the purer grades of precipitate to black-copper, reverberatories have been used in preference to shaft-furnaces, although they produce much flue-dust. Cement-copper has also been roasted and dissolved in sulphuric acid for the purpose of making copper-vitrol: it has also been worked up into paint. At Butte, Montana, precipitate is dried to about eight per cent moisture, barreled and shipped to Great Falls, where it is smelted in reverberatories. At Anaconda, and at Clifton, Arizona, it was the custom to throw it wet into blast-furnaces with the ore-charge, reducing it to matte; but recently the Anaconda company has completed a drying plant for treating the precipitate made at its Meaderville precipitating works.

When precipitate is smelted in a reverberatory furnace some of the copper is oxidized. To reduce oxidized metal the fused mass is "poled," and the proper amount of poling is when just sufficient cuprous oxide is left to oxidize the impurities present in the molten product. Upon cooling, cuprous oxide gives up its oxygen to other metals and metalloids present. Underpoled, or overpoled copper is brittle and of inferior conductivity.

It is difficult to give an approximate figure for the cost of producing merchantable copper from lixivium by precipitation with metallic iron, and subsequent treatment of the cement-copper in the manner outlined in the preceding paragraphs. Much will depend upon the quantity of material treated, as well as upon the skill of the metallurgist. It is, however, safe to assume that copper treated by the methods described will cost more, and probably will be less pure, than when the lixivium is electrolyzed, provided power is available at a reasonable price. Therefore, the cost of e'ectrolytic treatment of liquors will be alone considered in making an estimate of the expense of reducing ore by lixiviation processes.

The cost of electrolyzing a cupriferous lixivium, using insoluble anodes, will depend primarily upon the price of power, and secondly upon strength and character of solution. Passing an electric current through a solution of copper salts, with view to extraction of the metal, means an expenditure of power, and when that power is consumed in doing work other than deposition of the desired metal, the expense incurred must be correspondingly higher. Apart from loss of energy due to short-circuiting, leakage, diaphragms, chemical reactions, counter-EMF, etc., it is important to consider the resistance of the electrolyte itself. It must be borne in mind that the passage of electricity through an aqueous solution of any salt is always accompanied by movement of matter—in other words, power is expended in transporting ions of dissociated salts, and when there are present ionized bodies other than the metallic salts which are the object of the operation, energy can be wasted in doing unnecessary work. Some power is consumed in that it is transformed into heat through friction of the ions during transit from one portion of the electrolyte to another. The rise in the temperature of an electrolyte when the current is turned on is very marked, and the higher it gets, the more energy is being dissipated. It follows, that relatively the more copper-ions present (up to a certain maximum), and the less distance they have to be moved, the more copper will be deposited with a given expenditure of power from an electrolyte containing mixed salts. The influence of concentration of solution upon power expended is illustrated in the following table which gives the resistance offered by different strengths of a cupriferous solution to the passage of an electric current:

Table showing Ohmic Resistivities of Solutions containing varying Percentages of $CuSO_4$.

Percentage of $CuSO_4$ in solution.		Resistivity. Ohms per cu. cm.
0.01596	....	5438.32
0.0399	....	2469.74
0.0798	...0.01 normal...	1393.9
0.1596	....	801.28
0.399	....	390.93
0.798	...0.1 normal...	228.05
1.596	....	132.76
2.394	....	93.89
3.99	....	64.9
5.00	....	52.91
7.98	normal solution	38.8
10.00	....	31.25
15.96	....	24.87
23.94	....	20.83

As the EMF necessary to drive a current of a given strength through an electrolyte is in direct ratio to the ohmic resistance of the bath, it is clear that more energy is required to electrolyze a weak solution of copper sulphate than in the case of a strong one. For instance, a solution carrying 0.0399 per cent $CuSO_4$ (or 0.0158 per cent copper) would be comparable to ordinary cement-water issuing from a mine. To pass a current of thirty amperes per square meter (= 0.003 amps. per sq. cm.) through such a solution, the electrodes being five centimeters (about two inches) apart, would require $2469.74 \times 5 \times 0.003 = 37.046$ volts. But to electrolyze under same conditions a solution containing 7.98 per cent $CuSO_4$ (or 3.17 per cent copper) would require $38.8 \times 5 \times 0.003 = 0.582$ volt. The energy expended (kilowatt-hours) in overcoming ohmic resistance alone would be in the relation of 63.7 to 1, and in both cases the theoretical amount of copper deposited would be the same. It is therefore evident why electrolytic treatment of mine-waters has been unsuccessful, and it is also shown that it is more economical not to attempt to extract all the copper from a lixivium, but rather to utilize the cupriferous liquors as lixiviant after the point of economical extraction has been reached.

CONDUCTIVITY INCREASED BY SULPHURIC ACID.

In electrolyzing a copper sulphate solution, while copper is removed, thereby

weakening strength of bath in $CuSO_4$, free sulphuric acid is added to the solution in corresponding ratio, and deterioration in conductivity is therefore not as great as indicated by decrease in percentage of $CuSO_4$ contained in the liquor. However, the sulphuric acid formed is also subjected to electrolysis, which means an expenditure of energy. Hydrogen escapes at the cathode, and the oxygen liberated at the anode attacks the carbon composing that electrode. As an illustration of the quantity of energy consumed in electrolyzing a pure copper sulphate solution, even when considerable free sulphuric acid is present, reference is made to Table II (Mines & Methods, Vol. II, page 283). It is there seen that in electrolyzing a solution containing 3.26 per cent copper and 3.85 per cent free sulphuric acid, three volts were required to drive a current of about 6.1 amperes per square meter (=0.00061 amps. per sq. cm.) through the bath, even when sulphur dioxide was employed as a depolarizer. In this case the distance between electrodes was greater than five centimeters (about 10.4 cm.). The two cases, (the one mentioned in the foregoing paragraph and that just stated), are not comparable, because in the first instance only energy applied to overcoming ohmic resistance was considered, while in the last example cited the total EMF expended was given.

From the foregoing it is evident that deposition of copper through electrolysis of a copper sulphate solution will depend upon cost of power, composition and strength of bath, distance between electrodes, and other factors, and the best way to determine this cost is to experimentally electrolyze some of the solution in question. In the Reinartz investigation, which has been repeatedly referred to in these papers, it was determined experimentally that a copper sulphate solution containing 2.54 per cent copper could be electrolyzed at 1.9 volt. The details are given in Mines and Methods, Vol. II, page 284, Table IV. The cost of depositing copper in this instance was $0.0086 per pound, assuming power to cost $0.01 per kilowatt-hour ($65.37 per horsepower per year). This figure can be taken as a fair approximation of the expense entailed in depositing copper from a solution of the character and strength given, under working conditions that can be easily realized. At the same time, and in the same operation, Reinartz produced a liquor strong in sulphuric acid, which, if used in leaching ore, would rapidly accumulate ferrous sulphate.

To accomplish this economical deposition of copper, depolarization by means of gases from the roasting furnace is necessary. It has already been shown that 65 per cent of the oxygen liberated at the anode would combine with sulphur dioxide of said gases to form sulphuric acid and sulphates.

Collecting the costs designated in the foregoing as representing the expense incurred in the various stages of reducing an ore to metal, and assuming the ore treated to have an average content: copper, 2.76; iron, 12.4; and sulphur 11.6 per cent, the following total cost is derived:

	Per ton ore.	Per pound copper. (90 per cent extraction.)
Mining	$2.75	$0.0553
Milling	0.85	0.0171
Roasting	0.50	0.0100
Deposition of copper and preparation of lixiviant	0.4272	0.0086
Freight to seaboard, refining, marketing, etc.	0.7651	0.0154
Repairs and renewals	0.0676	0.0014
Total	$5.3599	$0.1078

No mention is made in this summary of interest and amortization, for the reason that it is the practice of mining companies to ignore these items when giving figures indicating cost of metal produced. Neither is credit taken for precious metals which might be recovered, as it is customary to do in giving cost of copper. The recovery is placed at 90 per cent of the copper in the ore as a conservative figure. If the extraction were 70 per cent—and this would be good practice with the methods now in use—the cost of mining per pound copper would be $0.0711 instead of $0.0553. With mining at $0.50 per ton, and extraction 90 per cent, the copper would cost $0.0625 per pound.

LEACHING PORPHYRITIC ORE.

With regard to leaching porphyritic ore similar to that upon which the above calculation is based, some data furnished by Rudolf Gahl (U. S. patent 1,-021,768, dated April 2nd, 1912), are pertinent. Gahl found that in leaching unroasted mill-tailings with a cold, dilute solution carrying sulphuric acid and ferric sulphate, a high extraction of copper could be effected at low cost in a short time, when grinding is carried far enough. As an example of the constituents of the lixiviant with which these results might be obtained on a slime carrying one per cent copper, Gahl mentions a solution containing less than one per cent ferric iron, and somewhat in excess of one per cent free sulphuric acid. The content of the solution in ferric sulphate is of minor importance: a weak solution works nearly as efficiently as a strong one, but the solutions must be freshly prepared (compare Mines & Methods, Vol. II, page 6).

Betts (U. S. patent No. 969,833, dated September 13th, 1910) supplies s
teresting data with reference to t
ufacture of ferric sulphate for
purposes. Betts states that if a
of ferrous sulphate and sulphu
be electrolyzed at a temperature
to 100° C., using a carbon anod
trolysis proceeds without app
polarization at the anode, and
evolution of gases, and a large
age of the ferrous salt is conver
ferric with high current ef
Betts mentions an instance where
containing 2.8 grams iron in t
of ferric sulphate, 1.6 grams as
sulphate, 1.75 grams copper as
sulphate, and about four grams f
phuric acid, in 100 cu. cm. soluti
electrolyzed at a temperature of
with a graphite anode. The curr
sity at the anode was eleven
per sq. foot. Only a slight pola
was in evidence beyond that ne
for forming ferric sulphate. Th
solution at a lower temperature,
creased current density and
showed extra polarization.

In leaching with sulphuric acid,
ric sulphate is a strong oxidizing
readily parting with some of its
and being reduced to the ferrou
it might in some cases be expe
oxidize the liquor coming from
cipitating vats in the manner i
by Betts. In depositing copper
sulphate solution, utilizing sulph
ide as depolarizer, naturally mos
iron present would be reduced
ferrous salt, which if raised to th
would assist in oxidizing any
sulphide remaining in an ore.

In the Bulletin of the Colorado
of Mines, January, 1908, there we
lished the results of some lixivia
periments carried out at that ins
by Messrs. Hollis, Lannon, Qua
Grommon. The material treat
Anaconda slimes, a partial ana
which gave the following comp

SiO_2	82.6
Al_2O_3	2.7
Fe	3.3
S	4.8
Cu	2.23
Pb	0.28
Ag	2.07
Au	0.03

A sizing test showed that 96.6 p
passed a 200-mesh screen.

Preliminary tests made upon
slimes indicated that no extrac
copper could be made by treatme
water alone, nor did the resul
when dilute sulphuric acid wa
When, however, sodium chlori
added to dilute sulphuric acid, an
tion was obtained amounting to
27.8 per cent of the copper presen
result indicated that dilute hydr
acid was a more efficient solv
the particular copper minerals i

slimes than was dilute sulphuric acid. In this connection it is well to remember that when an ore carries sulphides, the addition of free acid can produce sulphuretted hydrogen, and the liberation of a sufficient quantity of this reagent will precipitate copper as fast as the metal is dissolved. In this manner an impression can be acquired that a certain solvent does not attack the mineralized copper in an ore.

The leachings from which the data given below were obtained were carried out with roasted slimes. A series of preliminary tests showed that the best results were forthcoming when the slimes had been roasted in a muffle-furnace for forty-five minutes at a temperature between the limits 400°-470° C.—about the melting point of zinc, which fuses at 420°C.

Tests made to determine the proper proportion of free sulphuric acid to employ as lixiviant, showed that there were only very slight increases in copper extraction when the percentages of sulphuric acid varied between 0.25% to 5%. When five per cent of acid was used, iron commenced to go rapidly into solution while the percentage of copper dissolved increased very slowly. For this reason the lixiviant used in the following tests was made up to carry 0.25 cu. cm. sulphuric acid in 100 cu. cm. solution. It was further found, that the best ratio of lixiviant to roasted slime was seven parts by weight of solution to one part dry slimes, and that from three to six hours was ample time in which to complete the leaching. Addition of sodium chloride to the lixiviant gave no beneficial results with roasted ore.

EFFECT OF AGITATION.

Agitation during leaching, through the introduction of compressed air, resulted in an extraction of about 94.2 per cent of the copper, as against about 72.6 per cent by percolation. The exact percentage is not clear from the wording of the original, which does not give an analysis of the roasted pulp; the above percentages are calculated from copper-content of the raw slimes. Mechanical stirring without air did not give the same increase in percentage of extraction. Froelich (Metallurgie, April, 1908, pages 208-209), records a similar experience.

Froelich found that chemical action was greatly augmented through exposure of the pulp to the oxidizing action of the air during agitation as against simple mechanical stirring. Froelich (Mines & Methods, Vol. II, page 69), employed for the purpose an agitator comprising an endless screw working in a central well. By this means fresh surfaces of the pulp were rapidly exposed to air. Under such conditions any ferrous sulphate present in a liquor will be to more or less extent oxidized to ferric sulphate, thereby furnishing the lixiviant with a powerful oxidizer in addition to the solvent reagent, and this is, of course, beneficial.

In the Colorado tests the influence of ferric sulphate was indicated by the further fact, that after electrolytically depositing the copper from the lixivium the regenerted lixiviant worked better on the ore than did the original solution—it contained more ferric sulphate. If iron accumulates in the liquors in undesirable quantities, it may be removed by passing them over brush-piles (Mines & Methods, Vol. II, page 69.)

When the filtered lixivium was electrolyzed, it was found that if a high current-density was used the copper deposited was black and did not adhere firmly to the cathode. This was due to impurities present—iron sulphates, arsenic and antimony. It will be recalled that ferrous sulphate is electrolyzed at theoretical drop of potential of 2.02 volts: ferric sulphate at 1.62 volt, and copper sulphate at 1.21 volt. It was found that when the bath was not agitated the potential drop was not constant and varied with amount of copper in solution. After electrolysis had proceeded for some time, unless the current-density was slightly decreased, the cathodes showed a dark deposit. When the current density was dropped to a certain point, good deposition was maintained until all the copper had been removed from the solution.

At the copper-lixiviation plant erected near Arlington, N. J., in 1901, decrease in current-density was effected by increasing the number of electrodes progressively down the series of vats. Although th amperes of current sent to each vat was the same, the increase in electrode surface compensated for decrease in copper content of the electrolyte as it flowed through the succeeding vats Thus the density of current may be 15 to 20 amperes per sq. foot of cathode surface with a six per cent copper solution. and three amperes with a 0.5 per cent, provided proper circulation and sufficiently rapid movement of the electrolyte be kept up. At the Arlington plant it was expected that the expense for mining and metallurgical treatment of a two per cent copper ore would not exceed $2.50 per ton—at 90 per cent extraction this would amount to $0.0694 per lb. copper.

In the Colorado tests it was found that agitation of the electrolyte, either by compressed air or by stirring, permitted raising the current-density at least 100 per cent, depending upon amount of agitation and temperature of solution. The best results were obtained with a current density of one ampere per sq. foot at starting, with gradual decrease to 0.32 ampere per sq. foot at close. The lead plates employed as anodes produced a greater counter-EMF than carbon.

These tests were considered to afford a basis for the following estimate of cost of treating Anaconda slimes with an experimental plant of twenty tons capacity in 24 hours:

Interest, depreciation and insurance—20% on cost of plant	$ 5,000.00
Roasting 20 tons per diem—300 operating days—6,000 tons @ $0.50	3,000.00
Five men—300 days @ $4.00	6,000.00
Fifty electrical horsepower-years @ $50.00	2,500.00
Acid—35 lb. per ton ore, 220,000 lb. @ $0.01	2,200.00
Total operating cost per year	$18,700.00

With an extraction of 34 lb. copper per ton raw slimes (76.23 per cent) the yearly output would be 204,000 lb. copper, at a cost of $0.092 per lb. copper.

In the above estimate the assumed percentage of extraction is very low, and could be much improved in practice. Furthermore, the cost of acid could be eliminated, and the power consumption reduced, by utilizing roast-furnace gas as a depolarizer.

MORE ON CHINO IN PARIS

"L'Argent" of July 19th takes another clip at Chino and pays a compliment to Mines and Methods, as follows:

"Chino Copper—In April last we issued a statement of valuation on this society (company) which has been confirmed for the most part by our co-workers. But the last mail from America has just proved to us that the ideas did not know any bounds. The luxurious and very important review, Mines and Methods, reproduces in full what we wrote on this subject. The technical men who manage the publication in question have acquired a very special standing in the mining domain; they have reckoned, from having seen them, the value of the porphyric beds.

"The introducers (promoters) of Chino have tried to lay on the French public a fantastic commission in selling for $34 (170 francs) the shares ($5 par, or 25 francs) of an enterprise which has not yet given one cent of dividend. The stock is so suspected that one of our weekly co-workers (contemporaries) has demanded of the introducers nearly $1200 (6000 francs) to lend, for a single issue to the society (company) half a page of advertisement. Our very sincere congratulations to the courageous organ on the occasion of the destruction of this molar; it is as much as enters into the national patrimony."

Marcasite has the same composition as pyrite, but is distinguished by its crystallization and lighter color.

LOON CREEK DISTRICT; ITS GEOLOGY AND MINES

By J. B. UMPLEBY.*

The Loon Creek district is notworthy at present because of its gold deposits. These include lodes in which chalcoyprite and siderite carry most of the gold and placers along the streams in favorable places below them. From the lodes $350,000 has been derived, and from the placers possibly $1,000,000. The lode deposits have yielded $150,000 in copper along with the gold. Lodes of lead-silver have also been recognized in the district, but are inadequately developed. The ore found in them, however, is of excellent grade, being in many places clean galena carrying from 60 to 100 ozs. of silver to the ton.

Excellent iron and lime fluxes are abundant along the contact between the Paleozoic limestones and the quartz diorite south of Ivers. These contain about about 60 cents in gold and 1 oz. in silver to the ton—almost sufficient to pay for handling them. Whether or not they are contact-metamorphic deposits has not been established.

GOLD-PLACER DEPOSITS.

The Loon Creek Hydraulic Placer Co. owns six claims—in all, 470 acres—which extend from a point near the mouth of Canyon creek to the Loon Creek Narrows, 4½ miles north. The average width is approximately 1,000 ft. A strip about 75 ft. wide and 1 mile long, comprising the upper part of the central channel, was worked during the early '70s and is said to have produced a large amount of gold, occasional pans containing as much as $300. The gravels here were from 2 to 6 ft. thick, but back of them are gravel terraces which were not explored during the early days. The present owners prospected these terraces during two seasons, making an average saving of 25 cents a cubic yard. A flume capable of delivering 80-sec.-ft. of water to any point on the ground is partially completed and is part of a matured plan for hydraulicing the entire deposit. Heretofore water has been derived from two small streams—Grouse creek and White creek—but the present plans include a diversion of Loon creek at a point well above the placers.

The auriferous gravels rest upon a floor of schist which as now explored presents a comparatively even surface. The gravel beds are rarely more than 15 or 20 ft. thick, although locally attaining a depth of 30 or 40 ft. The individual pebbles are usually less than 6 ins. in diameter, but locally boulders up to 3 ft. and rarely 6 ft. in diameter are found at various distances from the base of the deposit. Being loosely cemented, the gravels fall apart readily when undermined by the giant. The gold is near bedrock, commonly in joints and shallow depressions in it, and as a rule is coarse, nuggets weighing more than an ounce being not uncommon, and perhaps 50 per cent of the product averaging 25 cents a color or more. Its market value is $18 an ounce.

GOLD-COPPER DEPOSITS.

A description of the Lost Packer vein constitutes essentially a description of the known gold-copper deposits of the district. Other veins are recognized, but they are little developed and have produced only returns from test samples. Promising among these is the Effa ledge, which outcrops a few hundred feet west of the Lost Packer vein. The Sunset and South Packer groups also present some encouragement to the holders, although the small amount of development on them has not revealed commercial deposits.

The Lost Packer vein is a fissure filling inclosed in mica schist throughout most of its extent, though in places it traverses granite dikes. Later than the vein are a number of flat-lying dikes of granite porphyry and diorite porphyry, which vary in width from 5 to 80 ft., those about 30 ft. across being most common. Ten of these dikes have been encountered and each one traverses the vein. The ore adjacent to them is usually crushed, and in places is separated from the intrusion by a gougelike layer as much as 3 ins. thick. The most important effect of the dikes on the ore body, however, consists of offsets. In places, there is a small lateral displacement of the vein as if the dike had entered a plane fault, but usually the intrusion has acted simply as a wedge, prying apart portions of the vein formerly contiguous and leaving them opposite each other along a course at right angles to its surface. As the dikes roughly parallel the ore body in strike but dip westward at a much lower angle than it, there is a series of offsets to the east with increasing depth on the vein.

The Lost Packer group of six claims and two fractions covers the known extent of the Lost Packer vein, which begins at Ivers and extends northward, successive portals being near the bed steep gulch which it approximate lows. The vein strikes north and and dips 75 degrees west. The d ment consists of 10 tunnels aggre about 10,000 feet in length, whi plore the deposit to a level 1,00 below its highest outcrop.

The vein varies in width from tion of an inch to 4 or 5 ft., ing perhaps 20 ins. In most pl lies between well-defined walls stand about 5 ft. apart, the inter material being gouge, sheeted sch ore. In many places all three ap the same cross section, but even the ore is usually a separate band to either the hanging wall or th wall, more commonly the latter. few places small lenses of ore oc the schist as far as 20 ft. from th but this is exceptional; usually th eralization is confined to the fissu

Three ore shoots, locally desi the north, south, and middle shoo recognized in the vein. These a nected on some levels by stringe as they are not of the same deg importance and as they present what different types of minerali they will be discussed separately north shoot is reached only by No. No. 3 tunnels. On the former it ft. and on the latter 250 ft. in Its average width is about 2 ft ore consists of coarse-textured m bluish-white quartz, with chalcoypr a little pyrrhotite and pyrite irre scattered through it, the chalcopy places inclosing small crystals other minerals. On No. 3 level sid rare, but on the next level belo equally abundant with chalcopyri presents a similarly irregular d tion. This ore body is compar lean, roughly sorted material r about $20 a ton—half an ounce o 2 ozs. of silver and 3.5 per cent c

The middle shoot is by far th important in the mine. It lies south of the north shoot and is oped from the seventh level to the latite capping, 700 ft. above. Li two others, it has a general pitch south. The southern limit of o fairly regular line, but the north ary is not parallel to it. Thus th is about 500 ft. long on No. 2 le narrows both above and below, its average length is about 300 ft

In places this ore body stands i relief at the surface as a honey quartz heavily stained by iron, t with a little manganese oxide a per carbonate. Usually, however, little or no surface expression. tion is unimportant in the depos mary ore predominating at a d

* From "Contributions to Economic Geology," Bulletin 530; U. S. Geol. Sur., 1912.

or 40 ft. and being exclusively present below 70 or 80 ft. The ore averages about 20 ins. in width, but locally is as much as 4 or 5 ft., wedging out on the ends of the shoot. This wedging out of the shoot seems to bear a definite relation to the tenor of the ore, for it has been commonly found that as the ore body narrows its assay value diminishes. Thus the ends of stopes temporarily abandoned are usually in ore running about $25 a ton, whereas the portion removed varies between $60 and $80 a ton. On No. 4 level the middle shoot is shorter than anywhere else in the mine and here also it contains a minimum amount of gold. Ore from levels both above and below ran 2 to 3 ozs in gold to the ton, but here less than 1 oz. was present.

The ore consists essentially of chalcopyrite distributed as bunches, small patches, irregular grains, and interstitial fillings in a gangue of coarse white quartz. The copper mineral constitutes about one-third of the total material mined. Siderite is present in small amounts, but not an important constituent. The chalcopyrite and quartz carry each about ozs. in gold to the ton, but less than half an ounce is present in the siderite.

The south shoot of ore differs markedly from the other two in the high percentage of siderite which it contains. It is 500 ft. south of the middle shoot and developed from No. 10 level to its outcrop near the portal of No. 6 tunnel. This body varies in length from 75 to 100 and is about 20 ins. wide. It consists of siderite and chalcopyrite in a gangue of coarsely crystallized quartz, in such proportions that the ore runs 26 per cent iron and 4.5 per cent of copper. Gold and silver, averaging half an ounce and ozs., respectively, are present. This shoot of ore is a valuable asset to the mine because it combines a fair amount of the precious metals and copper with an excess of iron, an element which must be added in the smelting of ore from the other shoots.

The three ore shoots worked in the Lost Packer mine have been described as separate units and as such they are mined, but in reality they are not distinct. All occur on the same fissure and on most levels stringers of low-grade ore connect them.

Considerable ore is blocked out in the mine and this will probably be materially increased during the present year. Returns from the last smelter run will be used to extend No. 7 tunnel beneath the north shoot and No. 10 tunnel beneath the middle shoot.

SILVER-LEAD DEPOSITS.

Silver-lead deposits have been found near the limestone area south of Ivers. The Lost Eagle claim and the Metcalf group are the principal properties, but neither is sufficiently developed to afford a satisfactory idea of the nature or extent of the ore bodies. Their difference, however, is thought to be of special significance and in order to emphasize this they will be described briefly. The Lost Eagle is situated on the divide between Canyon and Deer Creek cirques, at an elevation of 8,800 ft. above the sea. It is inclosed in Algonkian schist, though removed but a few hundred feet from an area of Paleozoic dolomitic limestone. The development consists of a shaft 50 ft. deep and a short drift from it. The vein, which strikes north 5 degrees west and dips 85 degrees southwest, is about 6 ft. wide and is bordered by well-defined walls. Between them is crushed wall rock inclosing bands and interstitial areas of argentiferous galena, pyrite and a little chalcopyrite in a quartz-siderite gangue.

The Metcalf property, situated about 1,000 ft. northeast of the Lost Eagle shaft, contains an irregular vein partly developed for about 100 ft. along its outcrop. The deposit is a fissure filling inclosed in granite near its contact with Paleozoic dolomitic limestone. The ore consists of argentiferous galena, which fills the fissure almost exclusively and varies from a narrow stringer in most places to a body 3½ ft. wide locally. The galena contains about 1 oz. of silver to the unit of lead.

In both of these deposits the amount of ore actually found is not of so much significance as its mode of occurrence. Both deposits are inclosed in rocks which are not nearly as favorable to the deposition of lead ore as limestone, even where that is impure; hence, in the opinion of the writer, the area of dolomitic limestone adjacent to them should be encouraging territory for the prospector. In the few places where time permitted an examination of the dolomitic limestone it was found to be rather intensely mineralized. The three iron mines which supply flux to the Ivers smelter illustrate this point. Each is a deposit of pyrite, now oxidized, which has replaced the dolomitic limestone.

SUMMARY OF CONCLUSIONS.

The more important points brought out in this preliminary report may be summarized as follows:

1. The Loon Creek district is a poorly prospected area of more than ordinary promise.

2. It is held back primarily by inadequate transportation, the nearest railroad point being 110 miles distant.

3. There are noteworthy gold placers in the area.

4. The principal gold-copper deposit has been explored to a depth of 1,000 ft., and throughout this extent the ore has ranged in value from $25 to $90 a ton, giving no evidence of impoverishment with increasing depth.

5. The area of dolomitic limestone near the head of Deer creek is thought to be a promising field in which to prospect for lead-silver deposits.

GEOLOGY'S RELATION TO ORE DEPOSITS

By WALTER HARVEY WEED.*

The Bisbee district of Arizona is second only to Butte, Mont., as a copper producer. Discovered in 1876, when lead ores were found, the ore body of the Copper Queen was discovered the year following, and has been mined ever since. The yearly production of Arizona is about 300,000,000 lbs. of copper. Of this Bisbee produces about half.

To the average desert prospector, the district shows very plain evidences of intense mineralization. The surrounding region has gray limestones, or cretaceous rocks, without any of those earmarks which experience has shown the world over to accompany great ore deposits. At Bisbee, however, there are craggy and castellated masses of dark red and brown ironstone gossan. Siliceous "blow-outs" occur in the limestones; reefs of rusty silica traverse the slopes; there is a characteristic coloration, silicification and presence of clayey, residual products, and a fine network of silica films along the crackled limestone, indicative of intense alteration.

It is evident that there was and is, no large amount of copper ore outcropping over the great ore bodies of the camp, but there are other evidences, and enough copper staining to arouse the interest of any keen-eyed and experienced prospector.

The district embraces the southern end of the Mule mountains, which like other desert ranges in Arizona, rises above the surrounding flat and gently rising plain, as abruptly as an island above the sea.

*In Mining World.

The mountains are composed of many kinds of rocks, which disintegrate under the torrid Arizona sun, and are split up and washed down by the torrential downpours of the rainy season, to form extensive talus piles and alluvial fans, stretching out from the steep mountain slopes, and binding height and plain with a skirt of greasewood-covered slope. Profound fault walls exist as bald cliffs, and other faults are marked by gulches swept clean by cloud bursts. It is a region where nature has laid bare the anatomy of the earth crust.

The immediate district is an area of Paleozoic limestone, resting on quartzite, that in turn lies over a great mass of schistose rocks. These limestones have been warped, folded and faulted in great blocks, and altered by intrusive masses of igneous rocks, notably the porphyry of Sacramento hill. This porphyry has come up along fault fissures, and spread out very irregularly as dikes and sheets, in part following the bedding of the limestone. In the ore-bearing areas this porphyry is much more important underground than it is at the surface. It has not only produced intense alteration of the limestones near it, changing them to marbles and a mass of lime-iron silicates, peppered with pyrite, but it has been the ore-bringer. The most recent developments of the district show a marked dependence of the workable ore upon the presence, or close proximity of porphyry, when near fault fissures.

All the known ore bodies occur within a block bounded by Mule creek on the north and by the open valley on the south, and extending from Quarry hill to a line through the Warren townsite on the east. These boundaries correspond closely to the chief faults of the district. Cretaceous rocks to the north and east cover the older beds and the porphyry, but are of little economic importance.

A close study of the ore occurrence of the camp shows that ore bodies occur in all the Palaeozoic limestones. It is apparently immaterial, at any rate from a mining standpoint, whether a claim is covered by Cambrian, Devonian or Carboniferous limestone.

A map of the known ore bodies of the camp, with cross sections, shows that the ore bodies occur is a gently inclined zone about 400 ft. thick, coming near the surface at the Copper Queen open cut (Czar), opposite the Copper Queen hotel and dipping about 15° southeast, so that the horizon becomes progressively lower and lower, southeast of Bisbee, and in places lies beneath the Cretaceous beds. The plane of this ore horizon corresponds closely to that of the tilted Cretaceous measures. No ore has been found north of the Dividend fault, and the ore-bearing zone extends about 3500 ft. west of it. Outside of the ore-zone thus delimited, only small and relatively unimportant ore bodies have been found.

Detailed studies of the workings of all the mines made by the several companies have shown that there is a significant association of ore bodies with certain breaks or fault fissures, and with masses of porphyry. These disolcations, of great lateral extent and proportionate vertical throw, have dissected the Bisbee Quadrangle into irregular blocks. Nearly all the producing mines are enclosed within an area bounded by the Dividend fault on the west and the Escabrosa line of fractures on the south. The main porphyry masses follow lines of faulting, but the intruded magma penetrated the sedimentary beds, bringing about conditions favorable to ore deposition. Again the cooling of this intruded mass induced a secondary series of fractures, contraction breaks, which have assisted in the general mineralization near intrusive contacts. The bedding of the limestones also has a marked relation to the ore bodies, but this relationship is more or less obscured by the cross fracturing and metamorphism of the country rock in the vicinity of an ore body. However, there is a decided parallelism of the tabular shaped deposits to the bedding planes of the limestone.

In a nutshell, close attention should be given to intrusive contacts and structural detail in the search for ore bodies in the district.

In the Bisbee district there is but little actual ore or quantitative evidence of the great mineral wealth existing below. The ferruginous ledges which occur in the limestone are here, as elsewhere in other parts of the world, certain indicators of mineralization. It is seldom that these limonitic croppings are ore-bearing though they always show some copper stains; but where found they are frequently associated with an ore body below. The limestones have been pyritized as a result of the invasion of the porphpry, and the reddish outcrops are the oxidation products of the pyrite. The soluble copper salts have been carried down by the percolating waters and deposited below, while the less soluble silica has been left on the surface.

The oxide ores are the resultant products of altered sulphides.

The two main lines of mineralized faulting in the district run 10 to 20° east, and an east-west series, called the Czar and Dividend faults respectively.

The irregularity of the ore bodies makes any estimate of ore rese ficult. It is said that the form ager of the Copper Queen, wh ing the mine over to Walter said: "At last we are through southwest stope; about two wee will finish it up."

That was over 10 years ago, stope has been worked continuou since, yielding many million po copper. This irregularity, mak estimation of ore reserves unce due to the projecting "fingers," may extend out irregularly fr main body of ore like tentacl devil fish, or again to the am clayey "casing," the altered mate rounding the oxide ores, and du action between the decompos phides and the enclosing roc great crystal studded caves, for w district was noted in the early its workings, are now worked stopes extending deeper to the zone in all the older mines, t new cave was opened up two y with mossy malachite walls, and er 75 ft. or more across. No o trict in America has furnis amount or variety of malachite the Copper Queen, nor handsom tals of azurite, cuprite and cha ite.

The newer mines of the Calu zona and other companies h yielded the wealth of mineral sp but their ores have been equally sent to the smelter. The ore opened up in the Shattuck mine, yielded 21,050 tons that average copper.

The sulphide ores which under great bodies of rich oxides, a lower grade, and often conta pyrite. Chalcocite is common in mediate zone, both massive and inated, in the soft, sooty form, far as observed by the writer primary.

The primary mineral is chal often forming great masses of s eral, as in the Junction mine, often occurring mixed with p that the ore as shipped to the carries 2 to 3% copper. The c yielded little concentrating ore, product going direct to the smel limestones above and near the mineralization, show a netting ica films that are sometimes iron but more often merely pale, or weathered surfaces. This n apparently due to silica depositi fractures in a crackled rock, an resembles the similar netting of and ferruginous films, characte the rocks above the ore body Miami mine, and the ore bodies

trix. Large fractures, which are sometimes faults, but more usually breaks in the rock without measurable displacement, are marked by lines of pale brownish silica, a coarser netting, with yards, instead of inches, between the fractures. On the borders of the developed ore bodies such quartz reefs, or barren veins, may be traced for a half mile or more, across the bare limestone slopes. The Shattuck fault is marked by siliceous masses, "blow outs," along its course, and the recently discovered ore body of this mine is beneath a chimney-like mass of this material, lying a hundred yards up the gulch from the main shaft of the mine.

As already noted igneous contacts have proven sure ground for prospecting, and the observant mine foremen have learned to follow dike contacts, until ore bodies are found. As far as I can learn this was first recognized as a guide to the discovery of ore bodies by Mr. Walker in the Shattuck mine, but both here and elsewhere it has proven to be a most useful trail to follow in running prospect drifts underground. In the instances observed by the writer, the contact is marked by some alteration, but the amount is often so small as to appear insignificant, and the absence of even a trace of ore is disheartening in many cases, though one may be quite close to an ore body.

The evidences of mineralization seen on the surface of the porphyry area near the Copper Queen mine, are to the writer's mind very strong and convincing, although apparently overlooked by most visitors, or if noted, disregarded, because the Copper King shaft failed to encounter rich sulphide ore. The writer's efforts to obtain control of this acreage some years ago were unsuccessful, and its exploration was urged at that time with great earnestness. It is now common talk at Bisbee that the development of this porphyry mass has revealed large bodies of rich ore, which will become an important factor in the production of the camp.

At the present writing the Junction is perhaps the most important single mine of the camp. As was fully expected and predicted years ago, large bodies of primary sulphide ore—chalcopyrite and pyrite—have been found in depth, and as the ore channels are traced towards the open valley, at lower and lower horizons, and in different geological formation. Naturally the most promising areas, judging from surface indication alone, were the first taken up, and the acreage owned by the Superior & Pittsburg—in part covered by a cement rock, a recent conglomerate—was not promising on casual examination. Where areas of limestone appear, there are, it is true, evidences of breaks and alteration by mineralizing solutions, but it required geological deduction, based on the platting of observed facts, to recognize that the trend of the chain of ore bodies laid in this direction, and this inference, drawn by Hovland and Smith, was the basis on which these properties were acquired and developed by the present owners. It was an application of geologic facts and inference to practical mining. To the writer, such use of geologic work to achieve commercial success, is not, as many geologists formerly held, a prostitution of science to commercialism, but a successful proof of the usefulness of science. It is a well recognized fact that mining fraternity throughout the world. Such investigation is usually too costly for any one company, even if the services of sufficiently skilled men could be secured. It is in the use of the results of such investigations and its application to individual properties that the usefulness of the independent practioner in mining geology is of value. The writer does not agree with those who expect the government expert to outline new development work or to predict strikes in any particular area. The most that can be expected of him is to show the value of surface evidences, and by careful consideration of the facts, structural and mineralogical, to give a diagnosis, even as a consultant physician called in by the ordinary practitioner in a difficult case, carefully considers the symptoms and gives an opinion.

EVOLUTION OF STAMP MILLING AT HOME AND ABROAD

By AL H. MARTIN.

Ore crushing with stamps was practiced by the ancients. In the time of Agricola the stamp mill was an established reality, and the ancient specifications were largely used throughout the limited gold sections of the world in mill construction until California practice developed departures and improvements. The ancient mill stamp consisted of a piece of timber with an iron head, with various expedients provided for its operation. Prior to the discovery of gold in California American gold mining was confined to the districts lying along the Southern Appalachian mountains, with the gold fields of Georgia yielding several million dollars. The ore yielded readily to the simple methods of treatment, and replicas of medieval mills adorned every active property.

The first plants erected in California naturally followed the design prevalent in other fields. The Georgia gold miners were regarded as most proficient and their lead was followed in all things pertaining to the mine and mill. But other men had come from the east—men of ingenuity and recourse—men admirably adapted for the consummation of the great work, demanded of their skill and patience. With such men devoting attention to the unwieldly plants, it is not strange that improvements were gradually made and that out of the numerous experiments emerged the prototype of the modern comprehensive reduction plant. All the old mills had square stems and lacked the power of rotation. The first round stem was designed in 1851 by C. P. Stanford and installed in a small mill operated on Nathemas Creek, El Dorado county. The round stem naturally compelled the use of a similar form for the shoe, boss-head and tappet. The bed for the mortar block and battery frame was composed of a successive layer of timbers, crossing each other at right angles. Sand was used to tamp the whole securely and water turned on to harden timber and sand into a compact body. The timbers and mortar block were placed directly on the ground. On the platform was mounted the battery frame. A low mortar surmounted the block, with planks used to build the sides to desired height. Screws, rods and bolts were freely used to secure the planks to the main structure. The first test was made with two iron stamps, 12 feet long and 2 3-4 inches in diameter. Results were so satisfactory that in February, 1852, a five-stamp plant was erected. After several months' activity, it was apparent that efficiency would be increased if the stems could be made to rotate. Several attempts were made, but to Isaac Fisk, an ordinary machinist, fell the honors. At first trials the corner of the cam rasped the edge of the tappet, and only after careful work and patient calculation was the cam given the proper curve to prevent excessive wear of the parts. Zenas Wheeler invented the gib-tappet in 1862 and installed it in a plant at Gold Hill, Nevada. The employment of copper plates for amalgamation developed in 1853. The perfection of the tangent-cam, deep vertical mortar block and other devices has been claimed by many, but rec-

ords fail to attribute the discoveries to any particular individual. The adaption of these improvements was evolved from the experience of numerous metallurgists, and their employment developed almost simultaneuosly in various fields of the state. With the development of the famous Comstock lode Nevada millmen introduced innovations, and to the men of this state belongs jointly with California inventors many of the devices used by early California operators. Most of the early mills were exceedingly crude in construction, and it was not uncommon for the mill to run the first half day and be hung up the second while repairs were made. By 1870 the California stamp mill had been developed to virtually its present form. The stamps usually ranged from 500 to 800 pounds in weight, with five stamps generally allotted to a battery, and two batteries operated from one cam-shaft. In some cases three batteries were thus driven. The standard stem ranged from ten to 12 feet long, with a diameter of three inches. Stems tapered as in modern models. The stamps generally dropped 60 to 80 times per minute from a height of eight to eleven inches. In some instances the mills recovered better than 90 per cent of assay values, according to official records, while in others the rate of recovery was low. Ore running less than $20 per ton was considered low-grade, despite its free-milling character.

All stamps used in early California practice were not of light pattern, the Rocky Bar mill, near Grass Valley, consisting of 16 1025-pound stamps, while the Allison Ranch mill in the same district contained 12 stamps weighing 1000 pounds each. The daily duty of a stamp was placed at two or three tons. After passing the copper plates the pulp was treated on blanket tables, and the resultant tailings permitted to flow to waste. In some mills a rough pine board was placed immediately beneath the iron lip of the mortar to indicate the interior condition of the battery charge, Hayward and other metallurgists preferring the board to a copper plate.

As practically all the ore handled in early California mining and milling yielded easily to crushing, amalgamation and blanket concentration, the problem of reduction did not offer especial difficulty, once a satisfactory type of plant had been evolved. Had the gold quartz of California presented the same refractory properties that marks the ore of many others fields, it is doubtful if gold mining in the west would have assumed such magnitude before long years after the discovery of the great veins of the Mother lode. Numerous valuable mines were deemed worthless because the gold failed to yield readily to simple treatment, and it remained for later generations to convert to profit what their fathers had scorned and passed by. With their own problems solved California metallurgists rested on their laurels and complacently watched workers in other fields develop more advanced methods. The average California stamp mill of today does not differ materially from the design perfected in 1870, save that larger stamps are employed, and vanners reinforce the canvas tables. In some districts the cyanide process is employed, but this method is still a virtual stranger in the great Mother lodge gold zone. With the ore yielding satisfactory values by simple methods, there has been no reason for the installation of complicated and costly processes merely because they have been advantageously employed in less favored fields.

With the experience of the California metallurgists and engineers guiding their way, the millmen of Nevada, Colorado and other American states have done much to add to the knowledge of metallurgy, while the engineers of Mexico, the Rand and other fields have played a prominent part in bringing the stamp mill to its present high state of efficiency. On the Rand particularly has the recent evolution of the stamp mill progressed along lines unrivalled by other fields. Many of the principles employed in the more pretentious mills recently erected in America are based on lessons and methods developed in Rand practice. The great aim of Rand metallurgy has been the crushing of immense quantities of ore at a low cost per ton of treated ore —a problem accomplished by employing massive stamps and mammoth plants. By this method low-grade ore has been treated profitably, and the Rand developed into the most stupendous gold field the world has ever seen. Of late many engineers contend that in the mania for an increasingly large production the limit of economic recovery has been passed, and there are signs of a reaction that will eliminate the abuses that have crept into the system. But whatever may be the merits of the different modes of treatment, it must be conceded that the Rand metallurgist has been a potent factor in placing the gold milling industry on its present basis. Engineering problems of a nature unapproached in most fields have been met and mastered, and the culmination of metallurgical enterprises is marked by the mighty mills that dot the reefs.

Pre-eminent among the great mills of the Rand is the monster Central mill of the Randfontein Central Gold Mining Co., Ltd., a subsidiary of the Randfontein Estates Co. The mammoth establishment embraces 600 stamps, each weighing 1650 pounds. In this country a 100-stamp mill is considered a massi stallation, while stamps weighing 200 pounds are considered extr heavy. When it is considered th Central mill is larger than six Am 100-stamp plants, the magnitude c wonderful Rand installation begins appreciated. The largest plant i world, it also embraces features makes it pre-eminent among go plants, apart from its gigantic c sions. The mill building has a len 635 feet and width of 70 feet, and is posed of steel. All of the mill fr is of timber, securely embedded o crete foundations. Timber pads placed under the mortar boxes, wi tumastic concrete under the concret blocks. The massive stamps ar ranged in units of ten, with fou ber king posts assigned to each A 100-hp. electric motor operates two units of 20 stamps.

Each stamp has a rated capaci 9¼ tons per day, but with the ance of the tube mills a much tonnage is handled. The mill st bins have a capacity of 13,000 to sufficient to supply the plant abou and one-half days. The stamps a inforced by 16 huge tube-mills, ea feet long and five feet six inches r meter. All the other department built on the same colossal scale. sand plant is arranged in two inde ent departments and contains 36 tanks, with diamaters of 60 feet. upper tiers of tanks serve as colle each of which delivers to two trea tanks. The sand plant consists tanks 70 feet in diameter. The are 14 feet high, with seven-foot bottoms. Three 12-inch Robeson-l son centrifugal pumps are used fo culating, transfer and discharge pur Two ten-inch turbine pumps handle solution decanted from the slime while a secondary pumping syste turns the surplus solution to the plant. The extraction departmen braces five zinc lathes, six 24-inch presses and 40 steel extraction boxe whole contained in a steel-framed ing 310 feet long by 70 feet wide.

Five mines supply the mammoth with ore. As the rock is taken each shaft it is loaded into 40-ton per cars and hauled over a railro locomotives to the 1000-ton reinf concrete storage bins, located di underneath the railway. Six belt co ors receive the ore and deliver to r ing trommels, 14 feet long by fou diamater. Conveying and sorting are provided to handle the fine coarse rock, and the clean material es to six steel sectional jaw-cru operated by 50 horse power motors. conveyors gather the product and

to two main incline belts commanding the main mill bins. From the latter the product is fed to the mammoth stamps.

The pulp from the mortars pass to the tailings pumps without amalgamation. Six ten-inch Robeson-Davidson pumps, operated by 125-horse-power motors, receive the coarse sands, while four similar machines are provided for the fine material. The tube mill discharge passes over 96 stationary copper plates, having dimensions of five feet three inches by four feet. The tube mills are arranged in two parallel rows, with all the amalgamating plates located between the two sections. Before admission to the tube-mills is permitted, the coarse sands are first elevated to cone classifiers, the underflow passing directly to the tubes. The classifier overflow goes to 128 tables, located in the middle of the building and above the tube mill plates, and on to the fine sand pumps which command the sand collecting tanks. Electricity is used throughout the mill, the company generating power at its own plant. The voltage is 3-phase-60 cycle, with 6000 volts delivered. By erecting and maintaining its own plant this company has not only reduced power costs, but has rendered certain the constant delivery of power, a factor that is appreciated by the operators depending for their current upon independent power companies. The dynamos are driven by steam, generated by 24 Babcock-Wilcox boilers

Besides the main Central mill, the Randfontein Central Co. operates four 100-stamp mills on its estate, making a total installation of 1000 stamps. The smaller plants are complete in every respect and excellent examples of modern mill construction, although naturally dwarfed by the colossal magnitude of the main Central installation. The Central mill commenced activities March 1st, 1911, and according to late advices is operating at approximately full capacity. With all the stamps operating at full capacity the company expects to treat about 3,100,000 tons per annum. In 1911 2,159,033 tons were treated, with an approximate recovery of $13,000,000. The company was the second largest producer on the Rand in 1911, following after the East Rand but ranked third in value of output, with the Crown Mines leading and the East Rand second. However, the Randfontein Central is expected to take first position in 1912, although it is certain its leadership will be determinedly contested by its two giant rivals.

Total value of ore per ton treated at the Central and auxiliary mills during last year was approximately $5.90. Costs averaged around $4.04 to the ton. Milling costs slightly exceeded $1.12 per ton. The Central mill was not operated at full capacity, and it is thought costs will be lower for 1912. The company has been handicapped in the past by scarcity of labor, and it was impossible to operate the gigantic plant at top speed throughout the past year because of this factor. The Central mill, because of its predominating dimensions and other notable features, stands forth as the most finished gold reduction plant in the entire world, and has been selected as a fitting culmination of the wonderful advance made in gold mill design and construction during the past forty years. Compared with the first crude mills erected in California, the wonderful Central plant towers like the gigantic skyscraper of the city above the unpretentious cottage of the village—a magnificient testimonial to the enterprise, ingenuity and recourse of the mining industry. The Central is not alone in its glory; there are other plants on the Rand approaching it in magnitude and accomplishment, and other fields have developed splendid examples of the modern mill, but the Central with its 600 giant stamps looms forth like the tungsten lamp among the ordinary electric carbons.

The builder of the Rand mill has had wonderfully favorable environments to spur on to great accomplishments. In the country nature has builded on a colossal scale. The mines are giants among giants, and what would be termed large properties in other climes are here considered insignificant. The property of the Randfontein Central alone is a fitting illustration of the magnitude of gold mining on the Rand. The holdings embrace over 2600 acres and extend along the massive outcrop about seven miles. Along this ore-belt two main shafts have been sunk to average depths of 1630 feet, and over 87,500 feet of development work was driven in 1911 alone. At the end of the year the ore reserves were estimated at 6,637,271 tons. Despite the immense amount of work performed the property has not been excessively opend, and large areas remain for exploration. And this property is smaller than either of its two great rivals, the Crown Mines or East Rand. When nature designs along such lavish lines it is not strange that man is stimulated to endeavors undreamed of in less favored fields. Under such conditions it is probable that many of the great problems remaining unsolved in gold milling will continue to claim paramount attention on the Rand—particularly the reduction of ore to the limit of economic efficiency.

SOLUTION METER FOR LEACHING PLANTS

By JAMES SPIERS.*

The machine to which I wish to call your attention is what is commonly known as a solution meter. Several of these machines have been described at various times, but so far as I have been able to learn, their use has been very limited. This seems rather strange, for the value of a machine which will automatically sample and register the amount of solution in a plant must be apparent to everyone. I cannot at the present moment recall the details of the machines which I have seen described, but it seems to me that there must have been something radically wrong in their design, or else they would have come into more extended use.

The solution meter here described is known as the Worthington liquid weigher, and was designed primarily for use in steam plants where the determination of the quantity of feed water used is frequently of considerable importance. Although generally used for measuring water, it has also been used for measuring oil and other liquids. Its use as a solution meter in cyanide plants is an adaptation of the machine to an entirely new line of work, but I believe that if you will follow the description closely you will agree that it is admirably fitted for this class of work.

As will be seen from the accompanying drawings, the machine consists of two measuring tanks of equal size (A-1 and A2), fitted each at one end with a siphon pipe (C) and at the other with weights (D). The tanks work on the knife edges (B), which are located at less distance from the counter weights (D) than the siphon pipes (C). The solution to be measured flows through the inlet pipe (E), passing along the deflector (F) into either tank, as for instance as shown in the drawing, into the left-hand tank (A-1). The weights (D) are so adjusted that the tanks will remain in a horizontal position until they contain a certain definite weight of liquid; then they tilt into the position shown by the dotted lines, and the liquid then begins to flow through the siphon pipe (C). After the flow has been started and the level of the liquid in the tank has fallen suffi-

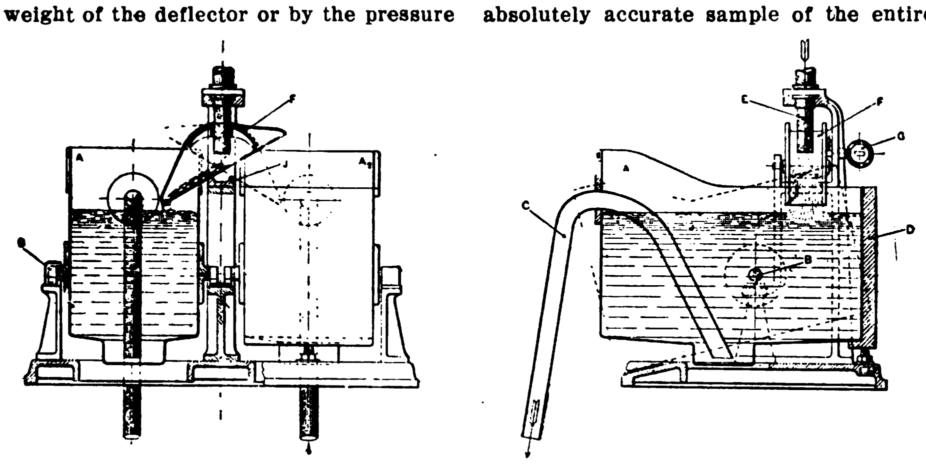
*In Transactions of the American Metallurgical Society.

ciently, the tank is returned to its original position by the influence of the weights (D), the siphon continuing in action until the tank is emptied. As each tank assumes the position indicated by the dotted lines, it suddenly tilts the deflector (F) over so that the liquid, instead of continuing to flow into the tank, (A-1), begins to flow into the other tank (A-2), when the same operation already described is repeated and continued. It will thus be seen that both tanks are filled automatically with fresh liquid, while the measured liquid runs into a collecting tank from which it can be drawn off continuously into the zinc boxes. As each tank tips, it registers the number of pounds contained on the automatic counter (G), which is actuated by the deflector (F).

When either tank is in a horizontal position the deflector (F) rests upon the support (T), not touching the tanks, therefore the time of tipping and the accuracy cannot be affected either by the weight of the deflector or by the pressure of the running liquid in the deflector or by the resistance in the mechanism in the counter.

It should be noted that the tilting of the tanks (and consequent recorded measurement) is accomplished entirely by the introduction into them of a definite weight of liquid, irrespective of variations in volume due to specific gravity. It is customary in cyanide work to base the tonnage calculations on the volume rather than on the weight of the solution. The use of a meter of this type in cyanide plants would necessitate a change being made either in the method of taking the solution for assay or in the character of the counter (G). The amount of error introduced by a calculation of a sample which has been measured out is not very great, but it is an incongruity and should be remedied. Personally, I would favor allowing the machine to remain as it is and the counter to register the amount of solution passed in pounds, and to weigh out the sample taken for assay, but I believe that the general opinion would be to favor a counter which would register the number of cubic feet of solution. A better way perhaps would be to design a meter specially for cyanide solutions and have the tanks so proportioned that the counter will register the quantity of solution which has passed through in tons and decimal fractions thereof.

The foregoing is a description of the machine as it is ordinarily constructed to weight solution. In order to use it as a sampler it is necessary to provide an auxiliary device which will remove a portion of the solution during the period of transfer. There are several ways by which this can be accomplished. The best way would be to provide an auxiliary siphon tube of glass alongside of the large siphon and which would come into action with it simultaneously. By drawing the tip down to a fine point, the quantity of solution delivered could be regulated to a nicety. If a siphon of this kind were placed on each tank an absolutely accurate sample of the entire quantity of solution sent through the boxes could be obtained. The only objection to this method of sampling is the large volume of solution obtained. This objection can be overcome without any great sacrifice of accuracy by putting a siphon on only one of the tanks, or by cutting off the short arm so that it extends down into the tank only a short distance. By regulating the length of this arm, the size of the sample taken can be adjusted to a nicety.



A Solution Meter for Cyanide Plants.

It will be evident to all that these meters will have to be used in pairs or even in sets of three or more, depending upon the number of kinds of solution handled in the plant. Where two or more zinc boxes are used for the same grade of solution, one meter can be used for the set, as they can be arranged to take their feed from the same tank.

In order to have a check on the zinc-box "clean up," it is necessary to provide a means of sampling the solution after it has passed through the zinc. This will have to be done by a separ[ate] device, of which there are a number [of] excellent ones which can be insta[lled] with very little trouble or expense.

The subject of providing solution [me]ters and efficient sampling devices [for] the cyanide plant is not a new one, [but] it has apparently received very little [at]tention. It is a matter, however, wh[ich] will grow in importance, for it is bec[om]ing more generally recognized every [day] that, wherever possible, exact sampl[ing] methods must be substituted for gu[ess] work. The machine which I have brou[ght] to your attention is one which I beli[eve] can be used very successfully in se[cur]ing the exact amount and at the p[res]ent time is very much needed in a gr[eat] many cyanide plants.

———o———

"Thomas," said the professor, "men[tion] an oxide." "Leather," replied Thom[as]. "What is leather an oxide of?" "[The] ox'ide of beef."—Exchange.

———o———

At the Bergwerkswohlfahrt mine (Zellerfeld district, Prussia), trials have been made with the Murex process for the further concentration of the galena containing intermediate products. After having been reduced by the reduction plant here to 1 mm. grain size, the ore is intimately mixed with magnetite dust and oil, and then passed over a strong electromagnet, which extracts the magnetite-coated galena particles and automatically deposits them in a laterally-attached storing bag, while the non-metalliferous stone particles pass on to the residue dump. The concentrates thus obtained contain up to 50 per cent metallic lead, and no more than 2 per cent remain in the residues.

———o———

Powder smoke can be quickly cleared from the face of an adit, where ventilation is secured by the use of a small blower and the usual galvanized-iron pipe, by reversing the direction of the blower. The smoke is thus sucked into the pipe and carried away without becoming mixed with the air of the adit or drift. A method commonly employed where machine drills are used is to turn on the compressed air just before firing the round of shots and allow it to escape continuously while the smoke is clearing away. The disadvantage of this is that the use of compressed air is an expensive means of securing ventilation, and since the smoke must be driven out through the full-section of the drift, a much longer time is required to clear away the smoke.

———o———

Gold is dissolved by **acqua regia, a** mixture of strong nitric **acid and hydro**chloric acids.

Mines and Methods

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Mines and Methods

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CONTENTS:

...se notice that this issue of Mines ...Methods begins the fourth fruitful ...of the publication's existence. It ...ot experienced in the three years ...losed one dull moment. For the ...it has taken in working for a square ...in mining, such as prevail in ...lines of commercial endeavor, it ...een showered with congratulations ...all parts of the world. It has been ...ible to make personal acknowl-...nt of all these, but we wish our ... and patrons to know that we feel ...l for every kindly expression that ...en made to us and that we shall ... future, as in the past, do the best ...n to deserve the same. When ... and Methods was started some of ...est friends doubted the wisdom of ...ove, while others became sportive ...anted to wager that not more than ...or four numbers would see the light ... Well, thirty-six numbers are now ..., and here we go for another dozen. ...in your dollar and get a receipt

THE STRIKE AT BINGHAM

Mines and Methods is not an advocate of strikes. It is deplorable that differences between employers and employed cannot be amicably adjusted without recourse to such destructive measures; but, weighing causes and conditions that impelled more than 4,000 men employed at Bingham to lay down their tools and walk out on the 18th of the present month, there seems to be no question but what the management of the Utah Copper Company is directly chargeable with bringing about the calamity. If that company has been telling the truth about its enormous earnings; if it is true, as the company's sponsors are continually declaring, that the company's earnings now amount to more than $1 a share a month on its more than 1,600,000 shares, then we say that the men who are daily taking their lives in their hands to serve the company are perfectly justified in demanding a raise from $2 to $2 50 per day for blasting and removing the rock from precipitous mountain sides; as also are those who are working in dangerous underground positions if they demand $3.50 instead of $3, or $3 instead of $2.50, as the case may be, when they know that men better treated and better taken care of, at Butte, for instance, are receiving an average of practically $1 a day more than the scale which their present demands call for? If the Utah Copper Company is doing anything like it claims, it is better able to pay miners even $4.50 per day than are the companies operating in Butte and the demands of the men ought to be met without a sign of protest.

On the other hand, if it should develop that the company is not earning at the rate claimed by it—and that was practically admitted by Manager Jackling Friday last when, in an interview with the Tribune, he said that, "nothwithstanding the present high price of copper, the operations of the company have not yet fully reflected this condition"—and if the real truth is, as repeatedly shown by this journal, that the management plays fast and loose with the shareholders of the company and the public in its vain attempts to create a "bull" market for the stock of the insiders, we then also maintain that the wages demanded by the men are not too high nor are they unreasonable.

During the year 1911, according to statistics published by a camp paper, nearly 1,000 men in the employ of the Utah Copper Company were victims of accident. Twenty-nine of these were killed and the rest were either permanently maimed or seriously injured. Not all of the other mines of Utah combined could be charged with such wanton disregard of the welfare of their employees as that, and it is not strange that finally the men, learning of the constantly claimed, boasted and paraded fabulous earnings of the Utah company, decided they should be better paid for their work and flirtations with death while accomplishing such results. Then the men charge that through a Greek employment agent of the Utah Copper Company they are required to pay a large sum to secure a job with that concern, while it was claimed by a camp paper several months ago that representatives of the company secured a portion of the blood money thus squeezed from the poor devils imported and unloaded at the company's mines just as so much inert machinery might be.

This controversy places the Utah Copper management in a bad hole and from the looks of things it will either have to make a lot of humiliating admissions or "come to time." More than a month ago the company saw what was coming and it undertook to prevent the breaking of the storm by announcing that certain classes of its employees would be given a "voluntary raise" of 25c. a day on September 1, which only placed the rate back to what it was when a previous cut was made, and when the company was just as strenuously declaring—away from home—that its dividend of $3 a share was being much more than earned.

Mines and Methods has regularly, consistently and insistently contended that the Utah Copper never has been the great earning proposition that it claimed to be; that had it not been for the periodical acquisition of new ground with real ore in it, coupled with the numerous sales of additional new stock, or the borrowing of money, it never could have maintained its position. We believe it is still in that position and had it not so blatantly proclaimed its false premises to the world it would not have created such a feeling of resentment from the miners of the camp

in which its properties are located. How the management is going to be able to recede from its position of a tremendously successful "self-contained manufacturing enterprise" and still maintain the confidence of the investing public (if it ever had it) is something we are unable to see. On the other hand, if it grants the demands of the men and continues its bold front, it will not be long until it will have to face a demand for another increase, as the example of the Butte miners will be constantly pictured to the men who do more hazardous work and still get much less for it.

The Utah Copper Company has been sowing the wind for several years; it is, apparently, just beginning to reap the whirlwind.

Utah Copper to Absorb Ohio

Considerable mystery surrounds the examination of the Ohio Copper property that is now being made. Several months ago Allen H. Rogers, then representing the Nevada-Utah interests, was in the camp examining the Last Chance claim. Since then he has returned and, it is understood, that he is now representing the Hayden-Stone interests of Boston. * * * On account of the close association of the Utah Copper with the firm of Hayden-Stone & Co., it is pointed out as possible that the company will take over the Ohio Copper company.

According to this statement, which is taken from the Bingham Review, a camp publication that is looked upon as the Utah Copper Company's personally owned mouthpiece, the long-expected is about to happen. Mr. Fritz Augustus Heinze, seemingly, is going to receive his price for the relinquishment of the Mascotte Tunnel and it is safe to predict that he is going to be well taken care of, so far as his stock interests in the Ohio Copper is concerned, as a part of the bargain. The rest of them, those who have paid their $1 a share for the purpose of aiding in the reorganization and payment of the outstanding obligations of the old company—or at least those not "in" on the deal—can take the 25c. a share for their old holdings, originally provided for, (if not yet turned in) or possibly get $1.25 for their new stock, with the $1 assessment paid.

Until the Bingham paper was prompted to "gently break the news" it was supposed by a great many innocent Ohio shareholders that the reorganization and assessment plan was arranged with a purpose of really pulling the company out of the hole. But no such luck. In effect, if appearances indicate anything, it is to be a repetition—on a smaller scale—of the Boston Consolidated and Nevada Con.-Utah Copper deals, where the insiders fixed the terms and the outsiders were compelled to take their medicine. If the deal goes through, and there is no reason to suspect that it will fail, those who have lost heavily in Ohio will have the knowledge that there is nothing to prevent them buying Utah Copper shares and, to make the settlement with Mr. Heinze and the rest of the insiders easier, those who get buncoed in Ohio will likely be granted the privilege of taking a stated portion of the new shares of Utah Copper stock that will, without much question, be sold to meet the purchase price of the Mascotte Tunnel property from Mr. Heinze. To make this new stock issue look all the more attractive for this play, the Utah Copper market manipulators have been steadily "washing" the price up for more than a month past. This feature of the scheme has been working in the face of a market that every half-honest reporter has repeatedly shown to be wholly professional—in a market which the public has been leaving severely alone for so long that even Daniel Guggenheim became discouraged and sailed for foreign lands bent on finding customers for his "securities" elsewhere.

These few remarks are offered so that the lay shareholders in Ohio may be enabled in a measure to grasp the situation and decide for themselves what is best to be done in case they find themselves in the boat that such a consummation of their utter route as we have outlined is visited upon them. We cannot swear that it will turn out just as we say—we simply draw our conclusions from what has happened before.

As for ourselves, we have long believed that Ohio and the Mascotte Tunnel properties would go the Utah Copper, because it provides the only outlet for the underground ore of the latter company. The first move in that direction came when the Utah Copper Company secured permission to extend the Mascotte Tunnel workings a distance of some 1800 feet in order to connect with the Hayden drill hole, sunk from the main pit of the Utah Copper's steam shovel workings; it became more apparent over six month ago when Utah Copper experts were engaged in sampling the Ohio mine. Both of these events were recorded by Mines and Methods at the time, and their significance was pointed out.

At different times, lately, the Utah Copper's publicity agents have told of the drill-hole prospecting at depth which has been going on and—as this work is said to have shown that, within certain prescribed and narrow limits bordering the Quinn fissure, ores carring 2 to 4 per cent was encountered—the natural thing to expect has been that a means of getting at this ore would have to be provided, at stated above. It does not appear that much is to be expected from Ohio ground at depth and it is claimed that only a few unimportant streaks of ore were found in running the 1800 feet from the Mascotte tunnel's workings, through Utah Copper possessions, as related above.

Those of our readers who have been following what we have had to say concerning the management of Utah Copper affairs from the beginning will remember that when the company, more than three years ago, was claiming that it had a self-contained manufacturing proposition, we showed that it had nothing of the kind; that it would be down and out within two years if it depended on making money with its steam-shovel methods of mining, in the territory it then owned. It will be recalled that our statement to this effect was fully justified inside of six months, when the company was compelled to secure the Boston Consolidated—not only to secure working room for the steam shovels, but also to secure underground ore with which to "sweenten' its steamshovel product sufficiently to give it the appearance of being commercially valuable.

When that deal was consummated, and knowing conditions, we made the declaration that even the Boston Consolidated acquisition could be relied upon only to defer the day of reckoning for probably another year or so. Within the next six months the Utah company was forced to buy the Barnsdall group of eight claims—in fact, it had to buy this group twice, for when the original deal was made the owner did not know that the Utah Copper Company had been mining out the rich ore from the group for a long time previous; but when he found it out, through Mines and Methods, he compelled the Utah Copper Company to shell out 6650 shares of its stock as a pacifier. That purchase of the Barnsdall group has saved the life of the Utah Copper Company up to the present time; it also has clinched the statement of Mines and Methods that the company must continue to secure new ground with real ore in it or quit.

Three years ago, and every few months since, the management of Utah Copper has been declaring in its reports that it would soon be ready to discontinue underground mining altogether; but each succeeding report has shown that, had it not been for the ores secured underground, "possible" and "probable" ore would have been about all that it could have supplied to its mills. These matters are mentioned to show that Mines and

ls has never made a single mis- ı dealing with the mismanaged af- f this company. Our contention was impossible to profitably con- team shovel mining operations at perty has repeatedly been verified aphasized in the different issues stock, or borrowing money against ale of which has been neces- meet the enormous expense of ng overburden, remodeling mills, order that the receipts from the copper might be made to appear ntly profitable to justify the pay- f dividends.

a few months ago no less an au- that Mr. Heath Steele, a promi- lining engineer of New York, conclusively that if the Utah Company had properly charged duction of copper what should een charged against it, the 1911 ds would be shown to have not arned by $1,500,000 at least. For two years and more every suc- report of the company has shown e grade of the ore treated was hing, until now it ranges at about 1.4 per cent, and this with all the ening" that can be given it by lition of the better grades of ore from underground workings in lton Con. and Barnsdall areas. In antime the amount of overburden le steam-shovels are required to is increasing at a rate which, as nths go by, will climb to propor- hat even a 17¾c. copper mar- not sustain.

e face of it all, and while an ef- being made to convince the world e company is making a clean pro- etter than $10 a share from its m operations—as a result of its ficent" steam-shovel methods—the ment seems to be dickering for ce to add other properties to its s in order that underground min- y be continued and the deception practiced may not become appar- ll the public shall have been bam- into relieving the insiders of the they have been forced to bear past four or five years in absorb- floating stock and sustaining the

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lean steel tapes that are badly the use of a mixture of lubricat- and cement is efficient. While icular proportions are necessary, ld not be so thick that difficulty in using it. Care should be taken ub too hard as the action is pow- d, used without judgment, wears metal.

THAT "MILL ROLLER" SUIT

On the 16th of the present month the Salt Lake Engineering Company filed a suit in the Federal court for $36,000 against the Ohio Copper Company claimed as due for ten sets of Wall's corrugated, horizontal crushing rolls and ten sets of Wall's vertical rolls, all of which, with the exception of four sets of corrugated rolls previously installed, were placed in operation at the Ohio company's mill, at Lark, Utah, between September 25, 1911, and February 20, 1912. In the abstract there is nothing in this of particular public importance, and the matter would not be mentioned here only that from the first day it became known that the Ohio company was going to equip its milling plant with the Wall patent rolls, no opportunity has been allowed to pass by interests unfriendly to the patentee of the rolls to prejudice the mining profession against their adoption and use in ore-reducing plants.

The filing of the suit in question was the signal for a portion of the local press —the Evening Telegram—to state that this $36,000 was "alleged to be owing for A SET OF MILL ROLLERS," certainly cognizant of the fact, through their familitary with ore-treating practice, that such a statement would seem ridiculous and tend to cast aspersion on the inventor and the claim for remuneration by plaintiff company.

It is due to all parties in interest that something of the truth should be known. Since the first installation of the Wall crushing rolls in the Ohio mill the company adopting them has been able to make a showing that it never previously dreamed of making; where it was previously losing a great deal of money on the treatment of much better ore than it has handled for many months past, the management has been able to show in official reports that its net earnings had reached more than $35,000 per month: that in the last year these net earnings had exceeded $300,000. In the face of statements made by the company's management showing what good work the Wall rolls had been doing, eastern market publications, inspired, unquestionably, by subservient tools on this end of the line unblushing declared that Wall's "contrivances" had failed to disclose any merit. Such dainty morsels of misinformation have been reproduced by a sycophantic local press with utter disregard of any favorable mention that may previously have been made on authority of Ohio officials, and with a purpose, apparently, of doing the bidding of some one to break down and crush anything and everything that is not initiated and promulgated as worthy from as miserable lot of incompetents as ever afflicted the mining profession.

The terms of the contract under which the Ohio company was enabled to install the Wall rolls could not have been more liberal. If they did not do all that was claimed for them the company had the right to return them in whatever condition they might be, without cost to the provisional purchaser. For mutual reasons the price was made extremely low and payment was to be made only from net earnings of the company. And, while the company has been reporting substantial net earnings for many months no proffer of payment for the crushing installation has been made to the Salt Lake Engineering Company, which supplied it.

The bringing of suit for collection was prompted, not through any desire to cause the Ohio company trouble, but because it has been apparent for some time that the control of the company and its mines and mill would pass into the hands of a corporation known to be hostile to anything or anybody having the remotest connection with the name of the inventor of these peerless crushing machines, machines that have demonstrated the Ohio Copper Company's ability to make money in a small mill on ore carrying barely 1% copper at a much better rate than has ever been possible with 1.5% ore in the mammoth mills of the Utah Copper Company, for instance.

These facts are related in the interests of truth and for the benefit of those whom it has been the evident purpose of purveyors of falsehoods to deceive.

The reason that window panes are whitened in a building not yet completed, is explained by a building contractor as reported in the New York Times. "We don't plaster them over with chalk to prevent the public from seeing the unfinished condition of the interior, but to keep the workmen from battering out the glass. Transparent glass looks just about as transparent as air to the man who is moving a wooden or iron beam in a hurry, and he is likely to ram the end of it through an expensive window, but when the glass is coated with white it becomes visible, and the workmen hand their material in through the door."

The life of machinery depends upon the treatment that it receives.

To preserve iron against rust, immerse it for a few minutes in a solution of blue vitriol, then in a solution of hyposulphite of soda, acidulated with chlorydric acid. This gives a blue-black coating which neither air nor water will affect.

UTAH COPPERETTES

No matter what the ultimate outcome of the strike at Bingham may be, it is not believed that it will be extended to the properties of the Alaska Gold Mines Company, in the mountains back of Juneau, even though they are under the management of Mr. Jackling.

* * *

The "New York Curb" devotes a great deal of its space these days to the stereotyped boosting literature of Utah Copper, Braden, Ray Con., Chino and Alaska Gold Mines, thus suspiciously indicating that it, too, is out for the dough. If it keeps "in tune," however, it will have to cut some of that "Spencer" stuff, because it is sure to detract from the "investment" value of the boost dope referred to.

* * *

Brokerage papers, "Market Letters" and correspondents of different mining magazines and newspapers, have been bowling along an interview with William B. Thompson, recently returned from a pleasure trip through Europe, in which he is made to say that "one firm of bankers in Paris has accumulated 250,000 shares of Utah Copper and is still in the market." We have known all along that strenuous efforts were being made to unload Utah Copper shares in France, but we did not suppose that one firm of "bankers" (or brokers) had been commissioned to try and sell so many; and we use the word "try" advisedly, because all the reliable evidence of the past year's struggle on the part of the Utah Copper Company's publicity department to create a demand for the stock —and particularly in France—has proven anything but "a howling success." These 250,000 shares referred to by Mr. Thompson are probably those which remained of the 300,000 originally listed by individual owners three years ago, and which have not yet been returned to this country. Mines and Methods showed more than a year ago that practically all of the first shares sold in Paris were thrown on the market at a loss by the Frenchmen who had bought them and that they were all taken in by the Utah company's representatives in this country. Again, it may be possible that the entire holdings of Mr. Thompson, consisting of 50,000 shares, all of which it is said were disposed of at about that time, have found lodgment in the strong box of some fool Frenchman. This, together with the number of shares mentioned by Mr. Thompson, would account for the entire amount listed, as related in this magazine at the time.

"The report of D. C. Jackling and A. F. Holden covering the Alaska Gastineau property should be studied carefully by investors who fancy shares in precious metal mines," says the New York correspondent of the Mining & Scientific Press. In this we fully concur, and to make it easier for investors we are reproducing that most illuminating document in this issue. We shall also give it space next month, so that men who do "invest" may commit it to memory and forever after know just what kind of bait they swallowed.

* * *

"Copper stocks were all firm. Utah Copper was picked up by bargain hunters, as were Chino and Ray Consolidated."—From Shotwell's New York market dope in Salt Lake Tribune of Sept 20th, just after the miners' strike at Bingham. In the same issue (Logan & Bryan market letter) we find this: "Utah Copper suffered from the liquidation incident to the unsettled state of affairs in the Bingham camp. * * * Of course, in the case of mining equipment being damaged, the company loss might be great, but from the standpoint of ore reserves, etc., the property could not be damaged." Of course not. Who could damage ore reserves the "indicated" recoverable values in which amount only to about fifteen pounds of copper per ton? Besides, you have seen how great tonnages are added to the reserves of the Utah Copper mines by simple calculations and revisions of the mine maps, as was done in the annual reports of the company for 1910 and 1911 when more than 200,000,000 tons were added by just a few strokes of the managerial pen.

* * *

That Mr. Jackling is a wonderful manager is not questioned in the least. The past ten years have brought him from an obscure position, as a metallurgist for a small mining company, to the position of the leading mining man of this country today. But, notwithstanding this, Mr. Jackling has had failures and a number of them. We can mention quite a few properties that have not been the success he and his associates in them have anticipated, and for this reason it would be well to thoroughly investigate the possibilities of the Alaska Gold Mines company before rashly making an investment in these shares. * * * We read that in his latest venture * * * over 2,000 stockholders have been enrolled on the stock ledger of the new company. We venture to say that not five per cent of these have investigated tl osition. * * * The lowest co given on mining underground ore Utah Copper is 68c. a ton and bodies in this ground are sevei dred feet in width and quite s easy to handle. Should the Alas be mined equally as cheap, ther still be the milling costs to add amount and, if it became nece use cyande, the costs would prob a great deal higher than the small allowed for this purpose.—Excer Market Letter of Dern & Thom Lake.

What do you think of that? ever before—outside of the p Mines and Methods—see or hear body in cold print questioning infallibility of Mr. Jackling? A here in his "home town," at th call Mr. Jackling a "wonderful m and then to charge him with h number of failures to his credit the same time to almost threa with exposure by declaring that " mention quite a few," is certain some. "Tintic," the title unde the market letter referred to is has evidently not been "gathe and "greased."

* * *

Judging from the remarkable " and activity" of Utah Copper s the New York exchange since t pany's mines and mills were clos as a result of the strike, it woul such a bad thing for the comp the president of the Western Fe of Miners did follow up his th cause a close-down of the Ray an When it can be shown that a company, so far, at least, as the price of its shares are conce worth more "dead" than "alive," the use of being burdened v bother and expense of operating ern brokers and other "bull" d including the "echoes" on this en line, have been explaining for t or more that the closing of Utal is going to create a famine in th metal market and, as the pric metal must as a result advance the shares of company stock w that much more, particularly as reserves" cannot be either dan frittered away by the strikers. the stuff!

———o———

When boards have become dis is, hollow on one side and rou the other, they may be straigh exposing them in the sun, round

romotion Cogs Slip in Alaska Gold Mines

powerlngly intoxicated with the nt success of the flotation of the laska Gold Mines Company's first g of shares, or else thoroughly ned at the prospect of ridicule they felt must follow an effort for its object the commercializa- vaunted names of engineers, were applied by Hayden, Stone & the distribution that was to have place one month ago. "Bankers okers" the country over apparently quick to perceive the purposes of lay" and they applied for substan- ed blocks of the stock; these mas- the art of market trafficing saw the game was and they decided to n as many shares as possible "$5 and promptly fire them back again e profit they knew must follow the ination of the promoters to jump ice up. Without considering any feature of the proposition, the pro- s evidently were just as quick to n—from the nature of the applica- for stock—that, should they recog- he applicants, they would be com- to disgorge the difference between ent payment of $5 and the washed- rket price, so they discreetly de- that owing to the heavy demands ide interests for the shares it would ossible to make the promised pro- llotments.

s possible, however, that the pro- s have deceived themselves to the of believing that the SEEMING rity of the offering would make it for them to retain the stock and out to the public at $8 to $10 a or at a premium over the "$5 of $3 to $5 a share. In this calcula- judging from the apathy displayed e public, the promoters have "reck- without their host," and the shares epose in the strong boxes of those sible for the flotation scheme.

t month's issue of Mines and ds contained the text of the pro- s' circular, including the "report" eminent engineers who recommend d, while every word used by Hay- Stone & Co. was included in our the public seemed to view the mat- a different light than that reflected brokerage presentation and would- vestors" closed the clasps on their t-books and decided to hold aloof ng further enlightment on the sub- Last month we had opportunity only to give a glimpse at the scheme of the promoters of this "wonderful proposition" and to predict utter failure as the ultimate outcome.

Readers, we are sure, wil agree with us that there was nothing in the original presentation of the proposition, as given in detail in the last issue of this magazine, to convince a prospective investor that there was even a reasonable chance for success. Hayden, Stone & Co.'s letter was flagrantly indefinite as to detail and it must be admitted that the "report" of Engineers D. C. Jackling and A. F. Holden (which is reproduced in this issue for memory-refreshing purposes) contains nothing—absolutely nothing—by which the real commercial value of the undertaking may be guaged. So we are going to help out a little by giving our readers a peep at the country in which it is proposed to operate, together with a few pointers touching the chances for success—something to help in figuring out just where they may expect to land if investors persist in chasing this golden rainbow.

The pictures and sketch map presented herewith are reproduced from Bulletin No. 287, U. S. Geological Survey, on "the Juneau Gold Belt, Alaska," by Arthur C. Spencer. These half-tone pictures and sketch map of the Gold Creek district, studied in conjunction with the "report" of Messrs. Jackling and Holden, and our review, will give a far idea of the value of the "report" of these eminent engineers, particularly as it relates to the chance of making a profit of 75c. a ton on ore the recoverable value of which they "indicate" to be $1.50 per ton.

The first half-tone gives you a picture of Juneau and a portion of the mainland coast line south from that town (at the mouth of Gold Creek canyon) in the direction of Sheep Creek canyon, between four and five miles southerly from Juneau. The water in the foreground is that of Gastineau channel, which divides the mainland from Douglas Island, on which is located the Alaska Treadwell group of mines, the surface workings of none of which have an elevation of more than 500 feet above sea-level and all ideally located as contributing factors in low-cost mining, milling and transportation problems. Note the precipitous character of the mountains in the picture showing Juneau; then imagine yourself climbing the canyon to the left and back of that town for a distance of some four or five miles and a perpendicular raise of 2000 feet or more and then glance at the second half-tone, in the foreground of which your climb would land you. Then study the view, which is in a southerly direction over and through the Perseverance property, (which the Alaska Gold Mines

Gastineau Channe and City of Juneau.

company has undertaken to buy), to the Sheep Creek divide, over which the southerly limits of the new company's prospective possessions is claimed to lie. Turn from this picture to the sketch map and you will see how the ground lies with respect to the new company's field of operations and how the Geological Survey's engineer has outlined the trend and width of the mineral zone. According to the government's topographical map of this region most of this territory embraced in the new company's prospective holdings ranges in altitude from 2500 to over 4000 feet above the Gastineau channel, or sea level.

The new company's eminent engineers explain to you that it is the purpose to drive the proposed Sheep Creek tunnel on the vein as the main haulage level (see second paragraph of the Jackling-Holden report), and if that is so and the Geological Survey's sketch of the

built a mill of 100 tons daily capacity on the property and Mines and Methods has it from a reliable source that it cost $75,000 to move the material for it up the canyon from Juneau. If the new company is to build a mill with 6,000 tons daily capacity at the mouth of its Sheep Creek operating tunnel—and it costs no more to deliver material, machinery and equipment at that bird-haven than it did to the Perseverance, $750,000 will do the hauling. But that is an item of cost hardly worth considering in a proposition where it is BELIEVED the ore can be made to yield $1.50 a ton! and it would not be mentioned here, only that we hope to interest possible investors in doing a little figuring before they "cast their bread upon the icy waters" of Sheep Creek or the Gastineau channel.

According to reports which come to us unsolicited the operating company mined

Upper end of Silver Bow Basin, Gold Creek, Looking Southeast Toward Perseverance and Groundhog Groups and the Sheep Creek Divide, Showing Nowell Placer Workings and Several Open Pits of the Alaska-Juneau Mine.

mineral-bearing lode is even approximately correct, mining operations will be conducted from a point about 2000 feet in the air above the level of the Gastineau channel, up Sheep Creek, and over the divide shown in the distance or background of the accompanying half-tone picture of the Gold Basin-Sheep Creek region. Everything thus shown and explained makes it plain, does it not, that particularly cheap mining in this region is not to be expected, no matter what claims are made?

Since the government report referred to was issued the promoters of the Alaska-Gastineau company, or its predecessors, owning the Perseverance property,

out the three richest shoots of ore in the Perseverance property (this was probably the ore on which the engineers of the new company base their estimates of $1.50 "indicated" recoverable value) and managed to get so far in debt that the holders of their bonds and notes have been glad of the chance offered to enlist the services of the great engineers and promoters identified with the flotation of the Alaska Gold Mines Company, to pull them out of the hole.

Since the organization of the Alaska Gold Mines Company considerable space has been devoted by the subsidized boosting press to accounts of what is done at the Alaska Treadwell properties, all

with a purpose, of course, of in
what "tremendous possibilities"-
la Jackling and Holden, we use t
"tremendous" advisedly—exist
properties of the new company
after Mr. Jackling's return from
the Deseret Evening News of t
(Sept. 2,) prefaces its remarks
ing Mr. Jackling and the new
with a lot of stuff concerning th
ations of the Treadwell which b
this way:

BIG OPERATIONS OF ALASKA TREA

Company Makes About $1 Per To on the Ores Treated—Gold Yiel $2.50.

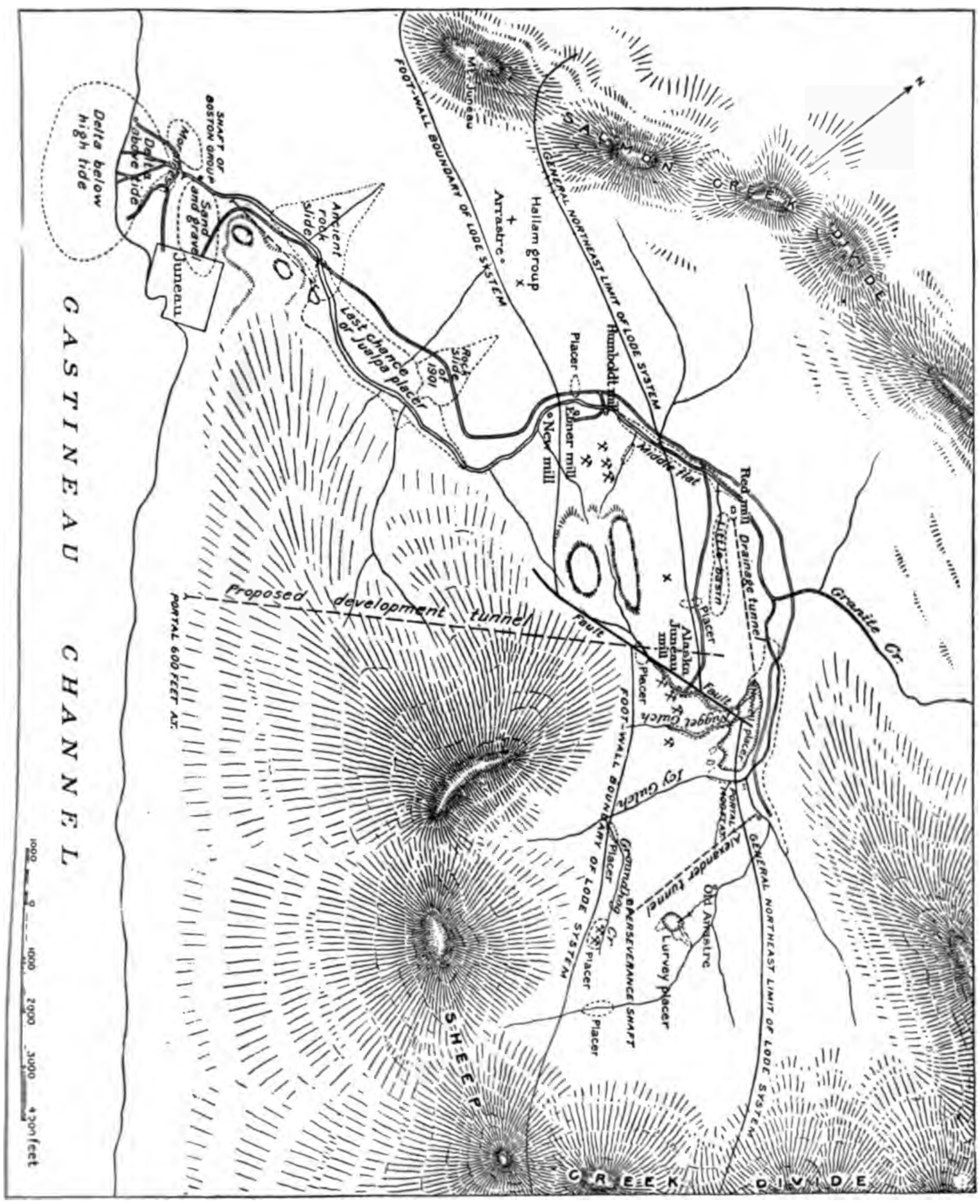
With the gold mining prope
Alaska taking a conspicuous pl
fore the public, and the enormo
on which future enterprises ar
planned, an account of the oper
the Treadwell property is not a
this time. The following is an
of the operations of the propert
recent month: Running a 240-sta
for 30¼ days, and a 300 stamp
19 days, the Alaska-Treadwell
crushed 64,120 tons of ore. The to
of gold was $160,000, or less than
ton. The net profit was $64,000,
cally $1 per ton.

Of course, if the unsophisticat
ing reporter for the paper quo
submitted that statement to Mr.
before he had turned it in for
tion it would not have been giv
licity, as it shows perfectly how
sible it will be for the Alaska Gol
Company to ever make a cent ou
in which there is recoverable va
only $1.50 per ton. You see the Tr
company, for the period referred
operating on ore with recoverable
of $2.50 a ton and making a p
$1. In other words, if the Alaska
well company, with its magnificen
ties for doing inexpensive work,
with experienced, high-class, hone
agement, had been operating on o
the Alaska Gold Mines propertie
cent of the recoverable value wou
been absorbed in the cost of prod

That being true, how does the
expect that a proposition like the
Gold Mines is going to win ou
cularly when it is placed in hands
with all the millions at comma
with what is claimed to be the
mining and milling proposition
world, a few miles from Salt Lake
supplies, labor, freight and all ot
ditions are ideal, has never been
approach the Alaska Treadwell
given by the News:

Before closing this review o
tions enshrouding the new comp
us refer briefly to the Geologic
vey's Bulletin and quote a few lin
Mr. Spencer's report. And here
digress long enough to say that E
Jackling and Holden's "report" wa
on personal inspection following
sion of reports to them by mys
UNNAMED engineers:

As in the other mines of Gold Cr



Geological Survey's Sketch Map, showing the Location of the Perseverance Property and the Sheep Creek Divide, Over and Beyond Which the Alaska Gold Mines Company Says It Will Operate. Limits of Lode System is also Shown.

Perseverance deposits are stringer leads in which the vein stuff is distributed through the country rock in the form of irregular vein fillings. The black slate, which is the principal rock, is intruded by numerous dikes and both of these rocks are cut by the ore stringers. * * * The structural trend of the country is about N. 40° W., as shown by the slaty cleavage, the course of the diorite dikes and the strike of the foot wall of the slate band in contact with the greenstone. * * * Mineralization extends through nearly the whole length of the lode system in Gold Creek, and is continued on the Sheep Creek side of the divide toward the southeast. * * * From the Ebner property on Gold Creek to the Silver Queen mine in Sheep Creek the distance is about five miles. The Ebner ores contain gold and silver in the proportion of about 7 to 1 by weight, while in those from the Sheep Creek mines the amount of silver is several times that of the gold. It seems that there is a progressive increase in the proportion of silver from northwest to southeast, for on the Perseverance ground the silver is from three to ten times the gold by weight, as shown by a large number of assays made for the Alaska-Perseverance company. * * * On the Perseverance property the veins are very much broken, so that it is impossib.e to mine the vein stuff separately from the country rock.

Time and space forbids going farther in this delineation of the fallacies of the so-called "tremendous possibilites" of this magnificent (?) propositon which, in the presentation by the promoters, is counted as "analagous to the low-grade 'porphyry' mines," with the added advantage, of course, that gold is not subject to market fluctuations, like copper.

FOR TRUTH OF HISTORY

Editor Mines and Methods:—In your August issue, this year, is a very valuable and interesting article, by C. F. Z. Caracristi entitled "Mineral Development South of Canal Zone." The subject would fill a book; but he has condensed it to the limits of his article and yet makes a most readable presentation. The region described is, acre for acre, all things considered, the richest in the world. Panama was only a province of Columbia, until our government forcibly wrested it from her, and the eternal verities require that we should return it to her, which can be done at no cost to any one. She has always been a devoted friend of the United States, and would make a better neighbor than its present government and people.

My object in writing is more than for anything else to correct an error. Senor Caracristi has fallen into, and others, more than he. He says:

"The interior of Columbia presents a vast field for future development when the railway facilities are to be had for getting into ths country, and when the canal is completed and the proposed inter-continental railway—the dream of the late Hinton R. Helper, who projected the idea before a convention in the city of St. Louis in 1848—becomes an accomplished fact."

The truth of history is that Colonel William Gilpin, Colorado's first territorial governor, was the person that made the speech on the subject and at the time named. He was then and had been for a long time a resident of Missouri. In 1873 he published a book entitled, "Mission of the North American People." Its introductory page has this legend:

"The Central Gold Region; the Grain, Pastoral and Gold Regions of North America, with some new views of its physical geography and observations on the Pacific railroad, by William Gilpin, late of the United States Army. First published in 1860."

In that first publication is a map of the world, his own, "Delineating the Contrasted Longitudinal and Latitudinal Form of the Continents; the Isothermal Zodiac and Axis of Intensity, Round the World, and the Line of the Cosmopolitan Railway and its Longitudinal Feeders."

In that 1860 publication was laid down, among others, a line of railway up and down the Pacific coast of North and South America. Mr. Helper evidently was ignorant of Gilpin's work, and believed his was the pioneer thought. In confirmation of that belief and of my correction, I submit the following from a letter he wrote on the 30th day of November, 1896, to his friend:

"His Excellency, Hon. Eurique Dupay de Lome, Envoy Extraordinary and Minister Plenipotentiary for the Kingdom of Spain, Distinguished Sir: * * * This being the 30th day of November, 1896, which is one of my most welcome and delightful anniversaries, I am vividly impressed with the fact that it is just thirty years today since I conceived, under somewhat extraordinary circumstances, the idea of an inter-continental railway through the three Americas, from Behring Strait to the Strait of Magellan, which, when built * * *"

This was six years after Governor Gilpin had mapped and elaborated the idea, and as I stated above, it is due to the truth of history these things should be known. I was familiar with his two books, and besides was honored by his personal friendship.

HENRY ALTMAN.

New York, Sept. 7, 1912.

MINE FOOD FOR WINTER

In the accompanying table is given a list of groceries and provisions consumed at Iron Mountain, Idaho, by twenty men (average) including cooks, during four winter months in 1909 and 1910, says Percy E. Barbour in the Engineering and Mining Journal. In addition to the list, lard was fried out of the two hogs listed as fresh pork. There were not enough fresh vegetables to last through the period and owing to the winter and snow-blocked roads, the can snowbound practically all of the no more could be obtained an place was taken by canned goods. the amount of cabbage, turnips, pa and one-half more onions and should have been provided. In a to the list were used sundry amounts of spices.

Fresh beef	
Fresh pork	
Fresh mutton	
Fresh fish	
Fresh chickens	
Fresh eggs	
Case eggs	
Ham	
Bacon	
Butter	
Flour	2
Graham flour	
Corn meal	2
Coffee	
Potatoes	
Carrots	
Turnips	
Cabbage	
Onions	
Parsnips	
Apples	
Salt	
Dried peaches	
Dried apples	
Dried apricots	
Dried prunes	
Raisins	
Condensed milk	
Canned corn	
Canned tomatoes	
Canned peas	
Canned peaches	
Canned pears	
Canned pumpkin	
Canned oysters	
Maple syrup	
Crackers	
Macaroni	
Cheese	
Sugar	9
Oatmeal	3
Beans	1
Molasses	
Jelly	3
Vinegar	
Baking powder	8 (lar
Pickles	
Lard	
Catsup	
Tea	
Chocolate	
Cocoanut	
Soda	
Yeast foam	
Cornstarch	
Chowchow	
Pepper sauce	
Currants	
Hominy	
Matches	
G. S. soap	
Tar soap	
Ivory soap	

The isolation of the camp ma cost of these supplies high a thirty-mile wagon haul was ex The total payroll deductions fo were $2318 ($1 per man per da just about equaled the cost of the boarding house, paying for plies and the cook's wages.

Rapid drilling by hand is not plished by use of heavy hamm forceful blows, but by hammers o size handled by men who know strike the blow that will cause t to cut and keep the bottom of t clear so that the drill is working rock and not on a lot of loose fra This is an art, and is only lea experience.

LEACHING APPLIED TO COPPER ORE* (XXII)

ROASTING PAEPARATORY TO LIXIVITATION.

By W. L. AUSTIN.†

Most solvents ordinarily employed for extracting copper from its ore attack the metal in its oxidized form more readily than when it is combined with sulphur. This is because oxidation must take place antecedent to leaching when, for instance, such reagents as sulphuric acid, ferric sulphate, and sulphurous acid are used in the lixiviation of a sulphide ore. It is obvious that if the solvent finds the metal present in oxide form, there is less work to do than when it must first be oxidized before going into solution. In leaching with sulphuric acid it is necessary that copper sulphides should have been previously oxidized, otherwise, with the weak solutions employed the metal is not satisfactorily extracted. If ferric sulphate is used as lixiviant, it acts both as an oxidizer and solvent, first oxidizing the copper sulphides and then bringing them into solution. When chlorine is the active agent in the lixiviant the copper sulphides are also attacked and dissolved, the reactions being materially assisted in the cases of some chlorine lixiviants by the oxidizing character of the salts present. Hypochlorous acid, and hypochlorous salts, are such oxidizers.

In considering the lixiviation of a given ore it therefore becomes of importance to decide whether oxidation of the copper constituents shall be effected by a preliminary fire treatment, or through the medium of chemical reagents: the relative expense incurred in carrying out the respective methods will naturally decide the issue. Instances may occur in which it will be cheaper to oxidize with the help of ferric or hypochlorous salts, but in most cases where oxidation is essential it will be found more economical to resort to roasting.

Oxidizing the copper content of an ore is not the only reason for roasting before leaching is undertaken: this treatment has a further beneficial effect, in that, by heating, the material is rendered more accessible to the solution. This is especially marked in the case of ore inclined to slime. It sometimes happens that ore which previous to roasting was almost impervious to solutions, is rendered quite leachable by light roasting—the water of hydration is driven off. With ore containing carbonates and sulphides, carbonic acid and sulphur are expelled by heating, and the mass is thereby rendered porous and absorbs solution.

Light heating with some classes of ore is said to effect a rearrangement of the molecules, and lays the copper more open to attack. For instance, Froelich (Imperial German patent No. 180,307 of 1902) has shown that chalcopyrite can be made amenable to leaching when it is heated for a short time above 200° C. without admission of air. By this treatment one-fourth of the sulphur content is said to distil off, and the color changes from blue-black to dark-brown. No copper oxide is said to form. Froelich represents the probable transformations by following formulae. $2CuFeS_2 = Cu_2Fe_2S_3 + S$.; $Cu_2Fe_2S_3 = Cu_2S + 2FeS$. A method of roasting which recovers part of the sulphur by distillation, produces no sulphur dioxide, and transforms chalcopyrite into a leachable product, certainly possesses the appearance of merit in these days of "smoke farmers."

Roasting copper ore for lixiviation, and roasting the same ore for smelting, are two distinct problems. In the latter instance the operation is carried only so far that sufficient sulphur shall be left in the roasted product to provide for a suitable matte-fall in the subsequent smelting: it is immaterial how the components of the roasting-charge rearrange themselves during treatment. On the otherhand, if the ore is to be leached it makes a very great difference in what combinations the copper, iron, etc., issue from the furnace, and the temperature at which the roasting is done has to be carefully watched. Failure to observe necessary precautions has been the cause of a number of disappointments in leaching undertakings.

ROASTING CHALCOPYRITE.

Copper occurs associated with other elements in the various mineralized forms which the hydrometallurgist is called upon to treat. Among the simplest of these are the carbonates and natural sulphates. The metal is also found in quantity combined with silica as chrysocolla, and as oxides; but by far the most common cupriferous minerals are the sulphides—chalcopyrite and chalcocite. It has been stated that copper is mineralized as chalcopyrite in two-thirds of all cupriferous ore treated.

The components of chalcopyrite are firmly combined, and authorities do not agree as to the grouping of the individual elements—but this is of minor importance. The essential fact is that the combination is very difficult to break up, as many metallurgists have from time to time reported who have tried to lixiviate raw chalcopyritic ore with solvents commercially available. Some form of preliminary oxidizing treatment has always been found necessary—weathering roasting, or chemical oxidation. Of these different methods, roasting is the one to which recourse is generally bad.

The progressive stages of oxidation through which the pulp passes during treatment in an oxidizing furnace, are explained in text-books and need not be repeated here. What concerns the hydrometallurgist most are the forms in which copper and iron are combined with other elements in the final products. If roasting is conducted at too high a heat, ferric oxide combines with cupric oxide to form a ferrite ($CuO.Fe_2O_3$) which is insoluble in most dilute lixiviants. This ferrite is produced with extraordinary ease even in the wet way. Ignited, black cupric oxide rapidly decomposes ferric chloride solution, producing a brownish-yellow ferrite precipitate (Kohlmeyer in "Metallurgie" 1910 page 297). If caustic potash is cautiously added to a solution containing equivalent amounts of ferric chloride and copper sulphate (or cupric chloride), so that no copper remains in the liquid, a voluminous dirty brown precipitate comes down. After ignition this precipitate appears as a clove-colored ferrite, free from cuprous oxide.

In roasting chalcopyrite the formation of copper ferrite is supposed to be brought about as indicated in the following formula:

$Cu_2S.\ Fe_2S_3 + 13\ 0 = (CuO)_2.\ Fe_2O_3 + 4SO_2$.

Thomas ("Metallurgie" 1904, pages 8, 39, and 59) proved experimentally that in the commercial lixiviation of chalcopyritic ore with ferric sulphate it is necessary to so conduct the roasting that sulpho-ferrite (chalcopyrite) shall be decomposed without forming oxy-ferrite. He also found that all copper ferrites resist the action of ferric sulphate solutions

In addition to the formation of copper ferrites in roasting cupriferous ore, combinations of copper oxide with silica are also to be guarded against. If the temperature in the roasting furnace is

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sufficiently high, fusible copper silicates form, coating the cupriferous minerals and protecting them from the action of solvents in subsequent leaching operations. In roasting Anaconda slimes (for analysis see Mines & Methods, 1912, page 556), Hollis and associates (Bulletin of the Colorado School of Mines, Vol. IV, page 113) found that when a batch was roasted at red heat in an assay muffle until all sulphur had been given off, the copper was insoluble either in dilute or concentrated sulphuric acid, or in ammonia. This fact was explained by the assumption that the copper was either converted altogether into silicate, or that the fine particles were covered by a film of silicate. Hunt (Transactions of A. I. of M. Es., Vol. X, page 18), found that in roasting sulphide ore, in addition to soluble cupric sulphate, the pulp contained insoluble oxides of copper, and a small portion of a cuprous compound, which though insoluble in water was dissolved by a solution of hot, strong NaCl, and was thought to be a cuprous sulphate or sulphite.

Thomas showed ("Metallurgie," 1909, page 474) that when a chalcopyritic ore is roasted at a very low temperature, a product is obtained in which copper is partly in form of sulphate, partly as free oxide, and partly as undecomposed sulphide, but free from FeS. A roasted product of this description was said to leach easily. On the otherhand, Kerl states that undecomposed sulphides in roasted ore are not attacked by dilute acids.

TEMPERATURES IN ROASTING.

When making a sulphating roast, the temperature of the furnace is of the greatest importance. It should be controlled with the help of an electric pyrometer, and must be restrained within prescribed limits. It is well to note the following: at 100°C. the last mechanically associated water evaporates. At 230° a part of the sulphur of the pyrites and chalcopyrite escapes. A yellowish-grey copper ore (20 percent copper) becomes darker: at 260° it is for the most part dark-brown with faintly shimmering scales, some brown in color, others displaying iridescence. At 340°C. the characteristic odor of sulphur dioxide may be discerned, and at 400° the roasting is in full action. After that the temperature must be very carefully watched to prevent undue rise.

Another writes states that sulphur is separated from copper sulphide, and begins to burn, at 325°C.: anhydrous ferrous sulphate is decomposed at 590°: and copper sulphate begins to decompose at 653°, producing a basic, yellow sulphate of the composition $CuOCuSO_4$. At 702°C. this basic sulphate begins to separate into cupric oxide and SO_3. Zinc sulphate is decomposed at 700°C.: lead sulphate at above 1000°.

The formation of iron and copper sulphates takes place at about the same temperature, but more copper-sulphate is formed than iron-sulphate at corresponding degree of heat.

In treating a certain concentrate, it was roasted for several hours at about 450° to 480°C. to produce copper sulphate. After the copper sulphate was formed, the temperature was increased to change iron sulphate into ferric oxide. There was no danger of destroying the copper sulphate already formed, provided the heat was not permitted to exceed 600°C. During the latter hours of the roast the temperature was raised to about 560°, and in this manner the decomposition of iron sulphate was effected to a considerable extent, which was of importance in the following leaching, for thereby an excess of iron was avoided in the solution.

Laboratory experiments made at the Colorado School of Mines for the purpose of ascertaining the best temperatures for roasting the Anaconda slimes previously alluded to, so as to produce the largest amount of copper sulphate, are interesting. These tests were carried out in a gasoline assay-muffle, at a temperature between a dull-red and a bright-red. Roasting dishes were used, and stirring was done by hand at intervals of about five minutes. In the first series of tests the roasting was of short duration, and temperatures were high.

No. of Test	Time Min.	Temp. °C.	Percent Copper Extracted from Roasted Pulp by		
			Water	2% H_2SO_4 Sol.	10% H_2SO_4 So
1	3	640	6.2	27.5	38.6
2	5	"	16.8	43.2	53.3
3	7	"	20.7	46.5	62.3
4	9	"	24.7	57.2	69.6
5	11	"	20.2	62.8	70.1
6	13	"	17.4	65.1	69.0
7	15	"	20.2	63.4	72.3
8	20	"	....	16.8	18.5

SULPHATES DECOMPOSED BY PROLONGED HEATING.

In the above tests it will be noticed that the best extraction with water was achieved after the pulp had been roasted nine minutes; the best with two percent sulphuric acid solution after 13 minutes; and the best with ten percent solution after 15 minutes. This shows that the sulphatizing of the copper was very rapid, and also that the sulphates were even more quickly destroyed. After twenty minutes roasting there was practically no copper sulphate remaining in the pulp, but there was still some copper oxide left which had not gone into insoluble combination with other elements, and could therefore be leached with strong acid solution. The temperature given (640°C.) was clearly too high for sulphatizing, because in none of the tests was the copper brought into condition for profitable extraction.

The next series of tests was made at a lower roasting temperature—just below a dull-red heat, presumed to be 520°C. The results are given in the following table:

No. of Test	Time Minutes	Temperature C°	Percent copper extracted from roasted pulp by	
			Water	10% H_2SO_4 solution
9	15	520	43.5	87.9
10	30	"	55.2	92.8

The effect of the reduction in temperature is marked; but that the muffle was still too hot to produce the best results was clearly shown in the next tests, which were made without any visible color at all. It should be remarked that in lixiviating the roasted pulps 100 cu. cm. of solution was used in each case—the weight of the raw slimes was ten grams in each test.

No. of Test	Time Minutes	Temperature C°	Percent copper extracted from roasted pulp by	
			Water	10% H_2SO_4 solution
11	15	450	61.4	99.1
12	45	"	64.6	99.6

At this temperature the molecular construction of the chalcopyrite was broken up so that a ten percent sulphuric acid solution could attack the copper; but either the heat was insufficient, or the time too short, to convert all the metal into sulphate soluble in water alone.

In none of the above tests was temperature accurately determined. To remedy this defect a sheet-iron drying oven, with two shelves, was fitted with a high-temperature thermometer. A long series of experiments was carried out with this apparatus, but the temperature could not be raised above 270° to 280°C. on the lower shelf. It was found, however, that by roasting six hours at 282°C., 94.6 percent of the copper content of the roasted pulp could be extracted with a ten percent sulphuric acid solution. This is further evidence that the molecular constitution of chalcopyrite may be broken up at a comparatively low temperature, and the copper content rendered leachable with sulphuric acid.

Another series of experiments was then carried out in the same muffle as at first used, with the difference that Le Chatelier's electric pyrometer was employed to determine the temperatures.

No. of Test	Time, Minutes	Temperature C°	Percent copper extracted from roasted pulp by 10% H_2SO_4 solution.
14	75	480	86.6
15	"	"	91.1
16	135	450	85.1
17	150	490	87.9
18	120	440	95.5
19	45	"	96.0
20	30	320	76.3
21	60	"	76.8
22	45	"	85.3
23	90	"	90.2
24	45	360	85.3
25	60	"	91.8

ECT OF THICK ORE-BEDS IN ROASTING.

hese last tests it is interesting to ıat No. 19 gave 96 percent extrac- ter 45 minutes roast at 440°C., and , 92 percent after 60 minutes at The conclusion reached by the do experimenters was, that the emperature for sulphatizing the ıda slimes tested, lay between 400° 0°C., and that 45 minutes roasting d. Some larger batches of slimes, l for the purpose of making leach- d electrolytic tests, gave results indicated that 45 minutes was not ınt time when a thicker ore-bed ısed. Whereas, the small tests 1 percent extraction with ten per- ulphuric acid solution, only 76 to ent was extracted from the larger

her data relative to temperature ting ore for leaching purposes will n in future articles; but some ex- nts made by Vondracek (Oesterr. 1906, page 437) with a mixture lcopyrite, argentite and quartz, is ting in connection with what has r been stated. The experiments arried out in small dishes while g a current of air over the pulp. ish was roasted separately and the emanating from the next follow- h were allowed to pass over the ing one. Each roast was then l with an equal quanity of water, olve the soluble salts. The fol- table gives the percentages of the nt metals contained in the original ıich were brought into solution.

m ri- o.	Temperature of roast	Percentages going into solution		
		Silver	Copper	Iron
	750°C.	31.3	17.5	Trace
	650	84.4	83.4	1.2
	500	90.6	88.0	1.0
	400	87.5	....	5.1
	300	96.9	95.9	6.1
	200	93.8	88.4	10.7

ırge percentage of the silver con- the pulp brought into solution is orthy.

NTITY OF AIR ADMITTED TO ROASTING FURNACE.

oasting sulphide ore an excessive of oxygen may have deleterious re- or when sulphides have been heat- a certain point, the elements of they are composed unite with the of the air, and the heat liberated xceed that desired for the opera- In this manner it may transpire ırticles of ore become fused, a con- which is, of course, very detrimen- subsequent leaching. For this it is desirable to always have the ion of air to the furnace under , and to watch the pyrometer care- t certain critical points in the fir- ıs soon as combustion of the sulphides starts, the air supply should be shut off temporarily. However, in carrying out a sulphatizing roast properly, it is essential to have a surplus of air in the furnace after danger of too free combustion of the sulphides has passed. It is thought probable that the formation of sulphates is assisted by the catalytic action of certain metallic oxides, and if sufficient oxygen is present, sulphur dioxide formed in one part of the furnace may be further oxidized, and in this state can unite with cupric oxide in another part. Sulphur dioxide and oxygen act upon one another very slowly when brought simply into contact, but there is quick action in the presence of a catalizer such as ferric oxide. The formation of sulphur trioxide should be assisted by supplying the oxygen necessary to raise sulphur dioxide to the higher degree of oxidation.

The admission of too much air to a roasting furnace may have the further effect of cooling the partially roasted charge below the point where the proper chemical reactions can take place. This is brought about by heating the excess of air at the expense of the furnace walls and charge. Therefore, in designing a furnace the proper proportions with relation to the work to be performed, must be carefully considered, and it is easy to see that a furnace admirably adapted to one class of roasting may be disappointing when called upon to perform another.

Should insufficient air be present in the gases passing over a roasting charge, the sulphur dioxide can reach proportions where it smothers the combustion. Sulphur dioxide is one of the most efficient fire-extinguishers known, and has been employed for that purpose.

DEGREE OF SULPHATIZATION OBTAINED.

It was shown in the foregoing that a high percentage of copper sulphatization can be obtained with proper roasting, even on a low-grade ore. It is obvious that when the constitution of an ore is such that a sulphatizing roast is possible this is the best method for adoption, because then the ore itself provides the leaching agent.

The richer an ore is in copper, the easier it has been found to bring a large percentage of the metal into solution. At one works where a 20-percent concentrate was leached, there was seldom less than 98 per cent of the copper rendered soluble in sulphuric acid. In the southern Tyrol concentrates were leached which analyzed 7.13 per cent copper. This material was roasted in a horizontal revolving drum so that from 95 to 96 per cent of the copper content was made soluble in sulphuric acid. Over 65 per cent of the copper was obtained in form of copper sulphate, soluble in acidulated water, with only a small quantity of soluble iron salts.

Other tests, made on low-grade pyrrhotite, showed that it was not difficult to obtain 97 per cent of the copper content soluble in acidulated water, with twelve hours roasting at 480 deg. C.

The time required to produce sulphatization of copper in an ore depends upon the means adopted for bringing hot oxidizing gases into contact with the minerals to be acted upon. It stands to reason that it will require more time to oxidize a bed of ore several inches thick, lying on a horizontal hearth, than it will the same ore showered through an oxidizing atmosphere in a rotating furnace. For this reason furnaces rotating on a horizontal axis have often been used for the purpose; but even then it has not been found practical to sulphatize quickly.

TYPES OF ROASTING FURNACE.

The various styles of furnace available for making a sulphatizing roast may be divided into three classes. (1) mechanical furnaces with horizontal hearths; (2) rotating furnaces with horizontal axis; and (3) kilns. The first two types may be further separated into reverberatories and muffles. Reverberatories in which the ore is roasted by hand have for the most part gone out of use, as they are not economical to operate.

Muffle furnaces are preferred by some from the fact that the gases resulting from combustion of the fuel used in firing are not permitted to pass over the ore. There are other advantages in employing muffles for roasting ore that is to be leached—the temperature can be better controlled and is more uniform. There are also objections to this method. For instance, as heat must be transmitted through the walls of the muffle, material which is disposed to fuse is apt to agglomerate, especially on the floors of such furnaces, as the underlying portions are the first to receive the heat and are protected from oxidation by the overlying pulp.

According to Thomas ("Metallurgie," 1904,) who instituted a number of experiments looking to the sulphatization of chalcopyrite, ordinary mechanical roasters suffice for this purpose. They also permit the use of pulp ground to moderate degrees of fineness.

With regard to roasters having horizontal hearths, in the Engineering & Mining Journal of March 21st, 1908, page 615, it is stated that in roasting a batch several tons of ore containing about 18 per cent copper and 16 per cent sulphur, the Wedge multiple-hearth furnace was able to bring the pulp down to 1.3 per cent sulphur (largely in form of sul-

phates) without the use of any extraneous fuel, notwithstanding the low sulphur content of the original ore. In roasting ore at Butte for treatment by Neill's leaching process, the sulphur content is said to have been reduced to 2 per cent by a Herreshof furnace.

As to roasters revolving on a horizontal axis, in heating chalcopyrite with exclusion of air, so as to break down its molecular structure in order that the contained copper might be extracted with solvents, Froelich recommends a revolving drum. In southern Tyrol, where leaching operations were carried on for two years, the sulphatizing roast was made in a horizontal revolving drum, externally heated.

Kilns were made use of at the Miedzianka plant, described in Mines & Methods for December, 1911, and at the Keystone mine near Globe, Arizona. In the first named instance the ore was pulverized and made into a paste with 5 per cent clay. This paste was molded into bricks which were dried by the waste gases from the kiln. The dried bricks were charged into the kiln and roasted, with careful regulation of the draft. In this manner the copper sulphide was said to be wholly oxidized, and was leachable in a solution carrying 7 per cent sulphuric acid.

At Agordo, in Italy, fine pyrites were made up into cakes with an iron sulphate solution. These cakes were dried and roasted—presumably in heaps—very little wood being required. At Freiberg, in Germany, the same process was tried; but the cakes broke up, owing, probably, to small lime content of the material used.

It is interesting to note in this connection the effect of producer gas in roasting. At a works where pyrites were used for generating sulphuretted hydrogen by passing producer-gas over them, it was found that the roasted material was brought into a condition for weathering to sulphate much more readily than when the same pyrites were roasted in heaps.

The unit of weight known as the carat, used for weighing precious stones, is equal to 3 1-5 grains troy. The term carat is also used to express the fineness of gold, in which connection it means one-twenty-fourth part. Pure gold is 24 carats fine. Twelve-carat gold is 12 twenty-fourths pure gold.

Shoveling contests at the Continental zinc mine, at Joplin, resulted in the winner filling 235 cars, each holding 2700 lb., in five and a half days, equal to 317 tons. Eighteen cents per car is paid for this work.

TIN DEPOSITS IN ALASKA

The United States uses between 40 and 50 per cent of the world's production of tin, yet American manufacturers are almost wholly dependent upon foreign mines for their supply of raw material. Alaska may make up a very small part of this deficiency, according to a report on the "Tin Resources of Alaska by Frank L. Hess, recently published as Bulletin 520-B by the United States Geological Survey.

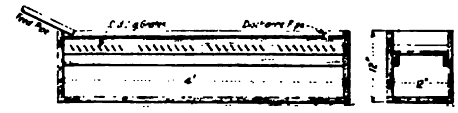
Tin was first discovered in Alaska on Buhner Creek, Seward Peninsula, in 1900. The next year stream tin was found on Buck Creek, which is separated from Buhner Creek by a low divide. In 1903 tin oxide was found on Cassiterite Creek, a tributary of Lost River, 20 miles from Buck Creek and about 100 miles northwest of Nome. Later discoveries of stream tin were made at several other places in the territory.

Of the tin placers none have shown much importance except those of Buck Creek. In the gravel of the creek bed the content of stream tin carrying about 65 per cent metallic tin has been found to be as high as 400 pounds per cubic yard in rich spots, though the average is under 30 pounds. In figures furnished the Geological Survey, the gold in the gravels has been estimated at 40 cents per cubic yard, at $60 per ton of stream tin, and at other amounts. Nuggets of gold valued at $20 or more have been found. When compared with the Australian and Malayan gravels, where the "black tin" content is in many places from 1½ to 5 pounds per cubic yard, the gravels of Buck Creek appear very rich, but the climate makes the conditions hard for placer working. The season is short, little or nothing can be done before June 15, and the freeze-up is apt to come by September 15. There are many storms, with cold, heavy rains, but, on the other hand, the country is very healthful. A dredge working in this district last year from September 10 to October 15 saved 92 tons of stream tin averaging 66 per cent tin, or an equivalent of 101 tons carrying 60 per cent tin, and sold for $52,000.

DRILL STEEL TEMPERING

In the Joplin district a unique method of tempering the drill steel is used. It is a modification of the plunging method that retains all the advantages of plunging while there seems to be little trouble from temper checking and few drill bits break off at the shank.

The method consists of using old worn-out jig grates to form a shelf to support the drill steel in the tempering tank, which is a rectangular box about 12 in. wide, 4 ft. long and 12 in. deep. This shelf is arranged so that there is from ¾ to 1¼ in. of water on top of the grates. In a few instances more than this depth of water is used over the grates, but that is not good practice as it is apt to result in breaking off of the steel at the water line. The shelf must be made of iron, for if wood were used, the hot drills would burn into the wood enough so that the bit would not be properly cooled, and a soft drill would result. A greater depth of water is used over the grates



with machine tempering than with hand work owing to the fact that it is difficult to keep the water as cool with the faster sharpening done with the machines, as when the work is done by hand.

There is a continuous feed of water going to the tank, and the amount is regulated so that by the time a drill has been put into the tank the temperature of the water is approximately at the temperature of the inflowing water. Of course the depth of the water on the grates is regulated by the overflow, which is generally a 1-in. pipe that takes the water clear out of the blacksmith shop before it discharges it.

In the presence of United States army officials and some other engineers, Marquis Roberto Imperiali recently exhibited near New York a new explosive, of which he is the inventor. According to a statement from the daily press, Imperiali pounded the substance between heavy hammers, melted it to a vapor in a chafing dish and heated it gradually to 400 degrees C. without causing an explosion. Afterwards, by the use of a fulminating mercury cap, he blew a 25-ton granite boulder into small pieces with 800 grams of the material. The inventor declares that only the mercury cap will cause the discharge and he asserts that the force attained is superior to that of dynamite.

Commenting on the "sootability" of Pittsburg, Graphite says that 40 per cent of the dust in that city is soot, and that its citizens wear plain black soots, with stripes when it rains.

In brazing cast iron, clean the parts to be joined, heat to a bright red, and apply a flux made by mixing the following ingredients: Boric acid, 1 lb.; potassium chloride, pulverized, 4 oz.; and 3 oz. iron carbonate.

Way Things Look at Tonopah Today

By AL. H. MARTIN.

The new era of Tonopah dates from December, 1909. In that month the Tonopah Development Company demonstrated the persistent character of the Tonopah deposits. Previous to this strike it was generally thought the orebodies were comparatively shallow deposits, and that the ore limits of the camp had been fairly well established. But with the Belmont discovery came the knowledge that the richest ore occurred in what had been considered almost barren ground. Since 1909 the development of Tonopah has progressed rapidly until today the camp stands first among Nevada's producing mineral towns. The total production of Tonopah mines from the initial discovery to present date approximates $54,000,000. Of this, the Tonopah Mining Company yielded about $30,500,000, and Tonopah Belmont $11,500,000. Montana Tonopah and Tonopah Extension represents the major portion of the remainder, with West End and MacNamara each recording about $1,500,000. Tonopah Midway has produced in excess of $1,273,000, while Jim Butler and North Star have contributed to the total. The remarkable factor in this mammoth yield has been the large profits disbursed. Approximately one-quarter of the entire porduction has been paid to stockholders in the form of dividends—a record practically unparalled by any other district of modern times. Total dividends paid by Tonopah companies follows:

Tonopah Mining	$ 9,250,000
Tonopah Belmont	3,218,000
Montana Tonopah	430,000
Tonopah Extension	323,586
Tonopah Midway	250,000
MacNamara	50,000
Total	$13,521,586

The history of Tonopah has been a record of daring ventures, superb faith and sustained courage. The camp has had its periods of elation and despondency—its eras of sunshine and shadow. From the first its founders were forced to battle with the prejudice always attending the development of a new field, while nature seemed to take savage delight in imposing apparently insurmountable obstacles in the path of the sturdy pioneers. The early prospectors were forced to contend with desert heat in summer and searching cold of winter; with water a precious commodity and transportation facilities nil. Pitched in the midst of the sterile desert only the wonderful richness of the surface deposits and the indomitable spirit of its founders forced the camp to the attention of the world. It was in May, 1900, that Jim Butler discovered the first ore in Tonopah, but it was not until the following August that he located the claim which subsequently became a portion of the rich holdings of the Tonopah Mining company.

The story of wonderfully rich ore brought to the outside world by Butler excited the interest of prospectors, and these hawks of the hills and gulches flocked by burro and pack train to the new El Dorado. Butler and associates leased portions of their holdings and the large tonnage of rich ore shipped out started the historic rush which evolved a new Nevada. Capital speedily became interested, investigated and purchased. In June, 1901, the Tonopah Mining Company was formed and the eight original claims held by Butler acquired for $336,000. Only $50,000 was paid in cash. The sale stipulated that the leasers were to be permitted to continue operations until December 31st, of the year, and out of the royalties paid by them to the company came the balance of the purchase price. Up to January, 1902, it is estimated the claims yielded about $3,000,000 from the Mizpah, Silver Top, Burro and Valley View veins. Despite the excellent record of the property is was with extreme difficulty that stock in the new Tonopah Mining Company was marketed. Mining was in such ill repute, and Nevada was so generally regarded as but the shadow of departed glory, that anything savoring of the industry or state was deemed fit subject for ridicule. The officers eventually managed to sell an issue of 350,000 shares of preferred, interest-

Camp of Tonopah, Nevada, as it Looks Today.

bearing stock at the par value figure of $1 by allowing a bonus of two shares of ordinary stock with each perferred share taken. The preferred issue was retired with interest in February, 1905. Thus many obtained for absolutely nothing stock that has paid magnificent dividends and is still quoted around $7 per share. With the inauguration of vigorous and successful mining by this company, the active history of Tonopah commenced. Other companies were rapidly formed and activities, often badly directed, incepted throughout the district.

In 1903 rich strikes in the Montana Tonopah estate added fuel to the fires of interest, and the wavering blaze was fanned into a mighty flame by a series of important finds in the West End, Tonopah Extension, Belmont, Midway, North Star and other prospects. A mad demand for stocks developed and soon prospects were held at values that would have been inflated prices for rich producing mines. As the surface high-grade shoots were exhausted and the less spectacular milling ore took their places the speculators wavered. Then came the inevitable reaction. Paper fortunes were lost overnight and the demoralized stockholders bitterly denounced Tonopah as the criminal chimera of unscrupulous promoters. In the first flush of its prosperity the camp was stricken by a malady fabricated by stock gamblers and irresponsible brokers. The 1907 panic quenched the hopes of many brave souls who had maintained sublime faith in the district's future, and for months it seemed that the camp which had shone so brilliantly in the first years of the decade was doomed to the murky abyss of oblivion before the cycle had closed. The Tonopah Mining company had continued its steady disbursements of princely dividends, but developments in the deep levels had been unsatisfactory, and the end of the giant property was gloomily prophesied by many who had once been its boldest advocates.

CHANGE FOR BETTER IN 1909.

This state of practical inertia and gloom prevailed until the close of 1909. Then came the great Belmont strike. The Belmont mine, hitherto regarded as a worthless consumer of good coin, instantly leaped into world prominence. The strike was made near the 1000-foot point and the theory that the Tonopah veins were not persistent was instantly disproved. From this time Tonopah entered upon a new cycle of progress and achievement. Other companies gathered courage; additional funds were subscribed, and deep mining became the slogan of the hour. At present there are twenty-two shafts in the camp that are down over 600 feet, while eight have passed the 1000-foot level. Total area of underground workings aggregates over 400,000 feet, or in excess of sixty-nine miles. Millions of tons of commercial ore are demonstrated and developments are constantly augmenting the source of future revenues. Including the old Belmont mill at Millers, the reduction plants of the district embraces 320 stamps. The Tonopah Mining company's Millers plant contains 100 stamps, and the new Belmont mill has sixty. The Montana has forty; the Tonopah Extension, thirty; the West End, twenty, and the NacNamara ten stamps, respectively. The Millers plant of the Belmont embraces sixty stamps, a portion of which is operating on ore from the Jim Butler. Recent figures indicate the mills effect an average recovery of 92½ per cent of assay values.

Belmont Mine, Tonopah, Nevada.

BELMONT PROVEN UP DEEP.

Paramount attention naturally attaches to the Belmont mine, the property which demonstrated the presence of huge deposits of commercial ore at depth and incepted the new Tonopah. The mine has been developed to a depth of 1446 feet by the Belmont shaft, and it is stated deeper developments will be inaugurated in the near future. In addition to the main Belmont vein, the Shaft and Lillie Bell veins show excellent character in the deep levels. The Belmont vein ranges around twenty-five feet wide in the lower workings and occurs in trachyte, or early andesite. The lies in the eastern portion of the with about 55,000 feet of undergrou velopments. An immense tonnag been developed, and the condition deemed so satisfactory that over ago the management determined erection of the most modern mill district. Not only was this step enced by the values encountere on the superior strength of th bodies as increased depth was ga

The building of the plant was orized in June, 1911, and prelir work on the site started the fol month. On July 25, 1912, the plan into action. It has a minimum capacity of 165,000 tons per annu is expected to result in saving per ton over the costs attending ments and treatment at the old plant. After reduction in rock-cr the ore passes to the mill bins. passing ore is weighed by an e weighing machine. Challenge f gather the crushed ore and deliv sixty 1250-pound stamps. Fro stamps the product passes to eig plex Dorr classifiers. Subsequent ment includes passage through eig tube-mills, sixteen Wilfley tables, thickeners, Pachuca agitators and ide plant. The Merrill system o precipitation is employed. The mi designed to treat all kinds of B ore, eliminating necessity of shi to smelters, and facilitating mill lower grade ores that were not d profitable to handle at the old plant.

The directors have consistent deavored to increase percentage recovery and reduce operating c policy that has been attended with ed success. In 1909 milling costs aged about $4.37 per ton, while costs aggregated over $7.81. In mining costs had been reduced t per ton, and the milling expen down to approximately $3.36 pe This record was made with the ol ers plant. Thus in four years th mont management effected a over first costs of $3.97 per ton treated. The figures strikingly ill the remarkable progress that ha made in reducing costs in the T district, and it is probable the nex or four years will record further sive advances.

TONOPAH MINING'S RECOR

The extensive holdings of the pah Mining Company have been de by about 139,500 feet of under workings, and 7,276 feet of core d The Mizpah shaft is down 1500 fee ing it the deepest in the district Silver Top shaft is down 740 feet a

Red Plume 700. The Sand Grass shaft is down over 500 feet and will be sent deeper. The Desert Queen shaft, controlled by the Tonopah Mining, but formerly used by the Belmont, has a depth of 1127 feet.

The Tonopah Mining produces its ore from the 700 and upper levels. The last annual report placed the available tonnage at 304,824, February 1, 1912. This was valued at $5,237,974. Mining costs for 1911 averaged $3.71 per ton, while milling costs amounted to $2.74. Marketing mill products, freight on ore, and metal losses in milling brought the total expense to $9.63 per ton. Despite the heavy costs the ore yielded a profit of $10.34 per ton. The 100-stamp Millers plant of this company has been so often described, and the method of treatment is so widely known, that details are here dispensed with.

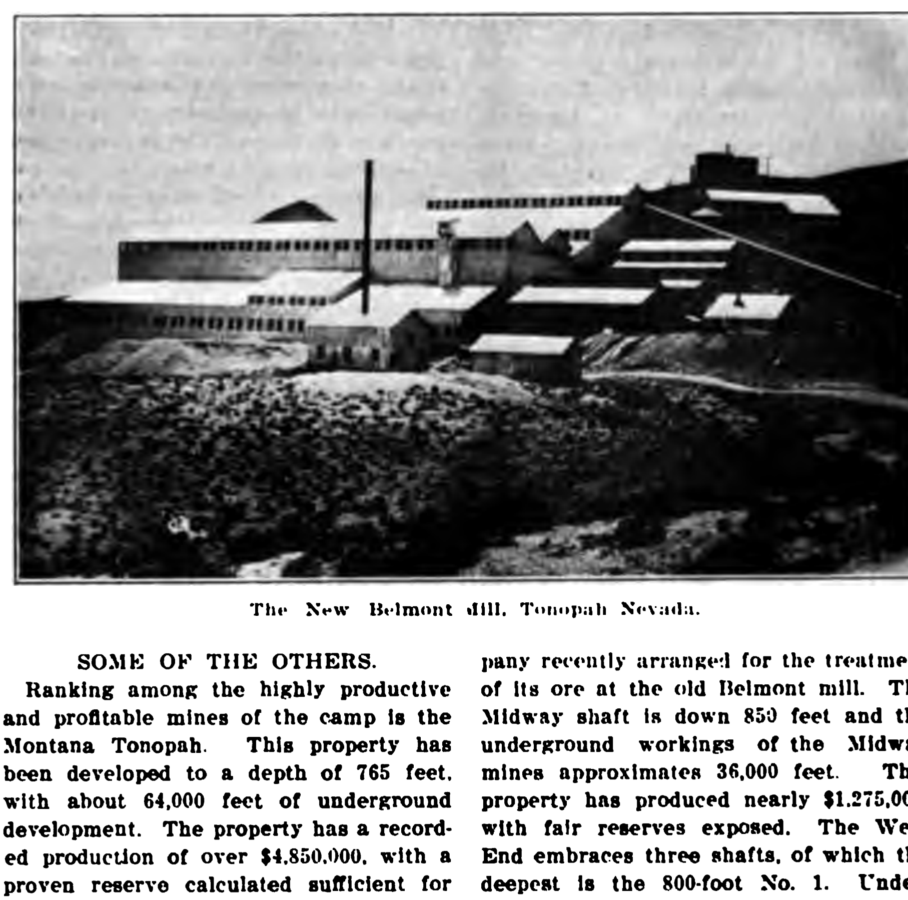
Besides developing the Mizpah mines to a high state of efficiency, the Tonopah Mining Company has been particularly active in endeavors to increase its sphere of operations. It has been long recognized that to prolong the profitable existence of the company other properties must be acquired, and the management is constantly searching for mines of merit. In the last annual report General Manager J. E. Spurr stated that offers of mines to the company averaged about fifty per month, but out of this large number only a few propositions were deemed worthy of investigation. Several properties are being considered and the success of the company at Tonopah may result in bringing prosperity to other districts.

EXTENSION PROMISES WELL.

The Tonopah Extension is one of the deepest mines in the camp. The Pittsburg shaft is down 1150 feet, and shaft No. 1 has attained a depth of 1050 feet. The Red Rock shaft as a depth of 700 feet. Deep developments in this property have been recently very encouraging, and the company has taken its place among the regular dividend disbursers. Like many other Tonopah mines, this property was formerly considered virtually worthless, but under the stimulus of skillful and energetic management has developed into an excellent mine. It is estimated a two years' reserve of ore is exposed, with steady developments more than keeping pace with production. The mill was one of the first to embody the lessons garnered from the operations of the older Tonopah and Belmont plants at Millers, and is an excellent type of the modern Tonopah reduction plant.

After reduction in a Kennedy crusher the ore is conveyed to the mill bins by a 16-inch belt-conveyor. Suspended Challenge feeders deliver to thirty 1050-pound stamps dropping ninety-eight times per minute. The stamps are arranged ten to a battery and five to a mortar, with each battery operated by a 30-hp. Westinghouse motor preforming 690 rev. per minute. From the stamps the pulp runs to Deister concentrators, where coarse concentrates are separated and removed, and the tailings passed to Dorr classifiers. From these the coarse material is received by two 5x18-inch trunnion tube-mills. These are equipped with El Oro lining. The tube-mill pulp and slime overflow of the Dorr tables flows to hydraulic classifiers where the coarse product is removed. The slimes pass to Callow cones and the thickened pulp goes to Deister slimers. After cyaniding the pulp is filtered by Blaisdell filters and the gold and silver precipitated by the usual zinc dust process. The Tonopah Extension boasts approximately 25,000 feet of underground developments, cylinder 15x18-inch hoist, operated by compressed air and using double-deck cages. The ore is crushed in cyanide solution by forty 1050-pound stamps, and the product treated by Wilfley concentrators, Dorr classifiers and Frue vanners. From the lower concentrator floor the product passes to the cyanide plant. Final treatment is accomplished by means of Butters filters and Merrill precipitating presses.

Among the other principal mines of Tonopah, the West End, Jim Butler, Midway and MacNamara have been most largely developed. The Jim Butler has a developed area of about 25,000 feet, with seven shafts on the estate. Of these the Gold Hill is down 800 feet, while the Wandering Boy has attained a depth of 700. The Stone Cabin is down 625 feet and the Tonopah City 575. The mine has produced $315,610 and the com-



The New Belmont Mill, Tonopah Nevada.

pany recently arranged for the treatment of its ore at the old Belmont mill. The Midway shaft is down 850 feet and the underground workings of the Midway mines approximates 36,000 feet. This property has produced nearly $1,275,000, with fair reserves exposed. The West End embraces three shafts, of which the deepest is the 800-foot No. 1. Underground developments approximate 25,000 feet, and the property has a recorded production of over $1,300,000. The twenty-stamp mill handles about 3100 tons of ore per month. The MacNamara developments approximate 13,500 feet. The property is equipped with a ten-stamp mill and has yielded about $1,600,000.

SOME OF THE OTHERS.

Ranking among the highly productive and profitable mines of the camp is the Montana Tonopah. This property has been developed to a depth of 765 feet, with about 64,000 feet of underground development. The property has a recorded production of over $4,850,000, with a proven reserve calculated sufficient for over two year's operations. The mine was among the first to demonstrate its merit in the district, and has come in for particular interest during the last two years. The veins range from a few inches up to fifteen and sixteen feet in width, with values varying from high grade to medium milling quartz. As in many other Tonopah mines the veins are marked by considerable faulting, but as experience has been gained less difficulty is experienced in recovering the shoots. The shaft has three compartments and is equipped with a double-drum twin-

Two properties that are attracting considerable attention at this time are the Tonopah Merger and Halifax. In the former the intersection of a rich shoot at a depth of 940 feet recently caused intense excitement, not only because of

its seeming richness, but also because it extended the demonstrated ore zone for a total length of about 9000 feet and a width of 3600 feet. The Merger shaft is going down to the 1075-foot point. With the culmination of this work extensive lateral developments will be undertaken. The Halifax shaft is down 1400 feet and is planned to develop a large area of territory considered practically proven by the Belmont developments. Several other properties are receiving attention, noticeably the North Star, Rescue Eula, Tonopah 76, Monarch-Pittsburg Extension, Gypsy Queen, Buckeye-Belmont and two or three others.

In the recent progress of Tonopah the fairly high price of silver has played an important role. Silver represents about two-thirds of the precious metal content of Tonopah ores, and every advance in price of the white metal means a corresponding profit. Tonopah is now producing about 10,000 tons of ore per week, having an average approximate value of $270,000. With additional shipments from the Jim Butler this record will be surpassed, while other properties appear on the eve of adding their contributions to the grand total.

LAWS GOVERNING EMPLOYERS' LIABILITY

By JAS. O. CLIFFORD.*

There are few subjects provocative of greater discussion than the Employers' Liability for Accidents to Employes, which is evidenced by voluminous literature on the subect. It is manifestly impossible here to do other than to present a few important constructions of the laws relative thereto, derived from various decisions given by the supreme States' Courts, and by the supreme National Court.

In the absence of legislative enactments the relations existing between empolyers of labor and their employes, and the reciprocal duties, rights, and obligations growing out of those relations, are governed by the common law.

The English Common Law is the basis of our doctrine of Employers' Liability, but this doctrine is constantly undergoing change, both by the rulings of the States' and the National Courts, and by the enactment of numerous statutes passed with a view to a more exact definition of the rights of the employe, or to some amelioration of his condition in other respects.

The purpose of the following statements is merely to state the principles and rules of the Common Law. Of course, the reader must bear in mind that, where they have been modified or changed by legislative enactments, any rule or principle of the Common Law conflicting with a statute which has not been declared invalid or unconstitutional by the supreme National Court, it is either modified or entirely changed by the statute, in which case the statute instead of the Common Law governs.

The principles of the Common Law are differently interpreted in the various State jurisdictions, indicating merely a locally recognized view which is not in accord with the generally accepted construction of the law. The results of these circumstances have been that the statutes, where enacted, range in form and effect from a mere restatement of the Common Law, to an abrogation of it in some more or less inclusive degree.

The great volume of litigation on the subject has not affected results of a conclusive character, due, perhaps to the fact that it is largely an effort to determine the boundaries between the risks assumed under the law by the injured employe, and the unlawful negligence of the employer in causing, or permitting, dangerous conditions to exist. The definitions of these factors often have not been accurately drawn, nor have those formed been so generally accepted as to secure uniformity. Again, the view formerly prevalent favored the entire assumption of the risk by the employe, while the gradual growth of the doctrine of the duty of his protection by the empolyer has given rise to a variety of decisions and statutory enactments, with the result that the existing body of law and practice in the United States is, in effect, largely of the nature of a compromise.

DEFINITIONS.

Employer.—One who employs; one who engages or keeps in service; one who uses or engages the services of another for pay. Construing the word according to the context it may include not only a master, but also a client, a farmer, a firm, a joint-stock association, a company, or a corporation, and the like (1)

Employe.—One who works for an employer; a person working for salary or wages; a person employed; one who works for wages or salary or w gaged in the service of anotl whose time and skill are occ the business of his employer; works for another for hire; hired to work for wages as the may direct, and so forth. (1)

The words employer and emp legally synonymous with the wc ter and servant.

Relation.—The relation of and employee is created by either expressed or implied, wh parties have the requisite lega cations for entering into a v tract. (1)

The relation exists only where son sought to be charged as and controls the other party to tract of service, or espressly assents to the rendition of the lar service by him. The emplo have the right to direct the the employe, and to either acce ject his service. The relation cease so long as the employe his control, or right of control, methods and manner of doing or the agencies by which it is Furthermore the relation exis the employe is employed, not employer directly, but by an in charge of a part of the e business, with authority to enga ance therein.

Contractor of Service.—A co employment is one by which ar er engages an employe to do s for the benefit of the employer third person, for a sufficient tion, either expressed or implie narily, when an adult person so ployment in a particular line the solicitation carries with i plied assertion that the one see ployment is competent to per ordinary duties of the position and it is an implied condition contract of service that the er competent to discharge the duti employment. (1)

Unless otherwise agreed, the an employe must be paid in c employer has no right to hand vest, or in any manner apply su whether beneficial to the em not, but must pay them directl

Labor Unions and Employers' tions.—Everyone has the right or to refuse to work, for whom what terms he pleases, or to deal with whom he pleases; an ber of persons, if they have r ful object in view, have the agree that they will not worl deal with certain persons or will not work under a fixed without certain conditions. T of employes to refuse to wor

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or in combination except upon ions and terms satisfactory to elves, is balanced by the right of yers to refuse to engage the ser- of anyone for any reason they proper. In fact both employers employes are entitled to exercise llest liberty in entering into con- of service. (1)

EMPLOYERS' LIABILITY.

employer is ordinarily liable in es to his employe who sustains an through the employer's negli- . Such negligence may consist in ing of something by the employer , in the exercise of ordinary care rudence, he ought not to have done, the omission of any duty or pre- n which a prudent, careful man , or ought to have taken.

two principal factors of the prob- re (1) the duty of the employer to le his employes in the discharge of duties with reasonably safe tools, nces, and work-places; and (2) the ption by the employe of the risk ed in the undertaking in which ntract of employment engages him.

duty of the employer will first nsidered, but it will be found im- le to discuss it without constant- aring in mind the modifications result from the existence of the ementary obligations resting on the ye.

DUTIES OF EMPLOYERS.

eral.—The duties of an employer at he is required to use due care e safety of his employes while they gaged in the performance of their This is assumed to include all able means and precautions, the in each particular case being taken consideration. If such provisions been made as a reasonably prudent would supply if he himself were d to the dangers of the employe's n, the employer will not be of negligence. The supreme Na- Court rules, that in the case of ations, they must exercise such n and foresight as a corporation lled by careful, prudent officers to exercise. The courts have, er, condemned any instructions g to charge employers with a high- ree of care than that which may ined as ordinary; and though the re is not an absolute one, it is tioned to the dangers to which nploye is exposed. In comparison other employments mining and urgical work are, in themselves, lly dangerous. In such cases e unusual danger exists) ordinary s advanced far beyond the re- ents of less dangerous occupa-

Instrumentalities.—Important obligations of the employer are to supply tools and appliances which are reasonably safe for the intended use, and reasonably well adapted to perform the work in contemplation. Closely related is the duty to provide a safe place in which to work, although, from the many decisions rendered, the distinctions between place and appliances is not an easy one to draw.

Improvements.—The requirement in the way of improvements, or the adoption of new safety appliances, is governed largely by the usual procedure of those engaged in the same business. An employer is not bound to introduce the newest and safest appliances, but he cannot disregard all inventions for securing safety of his employes. The standard of the custom of prudent men, and the law of general usage, may compel the adoption of new devices by employers, the omission of which had not been previously considered as negligence.

The condition that an employer must safeguard his employes from exposure to unreasonable risks is subject to the general qualifications that one has the right to carry on a business which is itself dangerous, provided it does not incur liability to an employe who is capable of contracting and who knows the dangers attendant on employment in the circumstances. Briefly, the employer and employe have a right to exercise reasonable judgment and discretion in the conduct of their respective affairs.

While the doctrine does not permit the use of unreasonably dangerous appliances, nor those which are defective or obsolete, or so inferior that their adoption or retention would indicate negligence, the question is not one of comparatively safety, but reasonable safety. Consequently no fixed rule of liability is possible, each case being of necessity decided by its own merits.

Maintenance.—As in the case of furnishing safe and suitable appliances and work-places, the same care is required of the employer to maintain such appliances and work-places. If the dangers in such instances are obvious, the employe, continuing to work with a knowledge of the danger and without complaint, assumes the risk and can not recover for injuries sustained, nor will liability attach until the employer has, or could have, information of the defect requiring repair.

Customary Methods and Intended Use.—Liability attaches only where the injury is the result of the use of an appliance for the work and in the manner for which it was furnished. The practice indulged in by employes of riding belt-conveyors, mine ore-trains, ore-loaded mine cages, and other agents intended for specific uses, is subject to the action that the employe assumes the risk, and can not recover for injuries sustained. This rule is qualified by continued indugence of the practice with the employer's acquiescence. The adaption of an appliance to new uses by the employer or his representative qualifies the rule.

Closely connected with the foregoing is the rule that an employer is not liable to an employe for an injury incurred by a departure from the customary method of performing work, or by changing his place of employment to some other department, unless on instruction from a properly authorized representative.

WORKING FORCE.

Coemployes.—Various attempts have been made to lay down some rule or formula by which to determine what employes of a common employer may be said to be coemployes. While the following definitins are said to be faulty, they nevertheless give a fair idea as to whom have been determined by many courts to be coemployes, within the rule exempting employers from liability for the negligence of one of them resulting injuriously to another: (1) Persons are coemployes where they are engaged in the same common pursuit under the same control, derive authority and compensation from the same common source, and are egaged in the same general business—though it may be in different grades or departments of it—are coemployes who take the risks of each other's negligence. (1)

The principal limitations contended for on the general rule in regard to coemployes is that there is such an employe as a vice-principal who takes the place of the employer, and who is not a fellow employe with those beneath him; and there are many variations of the idea to the effect that every superior employe is a vice-principal as to those beneath him.

Whether one is acting as the representative of the employer, or merely as the fellow-employe with others employed by a common employer does not depend upon his rank or title, but upon the character of the duties he is performing at the time another employe is injured through his negligence. If at such time the offending employe was in the performance of a duty which the employer owed his employe he was not a coemploye with the one injured, but a vice-principal. The rule is fundamental that an employer can not rid himself of a duty he owes to his employes by delegating his authority to another and thus escape responsibility for neg-

ligence in the performance of such duty. If, however, at the time of injury the negligent employe was not engaged in the performance of a duty from the employer to the employe, but was discharging a duty which was due from the employe to the employer, he was a coemploye to the one injured, engaged in the same common business, and the employer would not be liable for the injuries sustained by reason of his negligence.

Duties Nondelegable.—The courts in general have held quite consistently to the view of the nondelegable quality of the duties enumerated, their rulings being that, as to employes, the employer can relieve himself only by performance. In some cases, however, it has been held that the appointment of an employe to the duty was a sufficient discharge of the obligation.

Incompetency of Coemployes.—If an employer knowingly employs or retains in his employment an incompetent employe, he is liable for an injury to his fellow-employe sustained through the incompetency of such coemploye. Of course, an employer does not warrant the competency of his employes, but he must use all ordinary care and diligence in their selection and retention. If he has not been negligent in selecting an employe and subsequently obtains knowledge of the employe's incompetency and still retains him, he is liable to all other employes for any injuries resulting from said incompetence. However, no employe is entitled to damages for any injuries resulting from said incompetence on the part of a coemploye when he knew of such incompetence and did not inform his employer of same. It must be considered, however, that neither incompetence nor unskillfulness will be presumed; they must be proved. The disqualifications of persons of suitable age may be mental moral, or physical, the most common being those that arise from the intemperate use of intoxicants, through habitual carelessness or recklessness—such as may reasonably come to the knowledge of the employer—likewise charge him with liability. A single act of negligence or incompetence of an employe is not enough to fix the employer's liability for continuing to employ the employe guilty of the same.

It is, therefore, quite apparent from the above statements that the employer must be reasonably and properly careful and diligent to see that each employe hired by him has such qualifications as will enable him to perform his duties without greater risk to himself and his coemployes than the business necessarily involves.

Rules and Warnings.—Another branch of the employer's duty is that of providing appropriate rules, and the carrying out of a suitable system for the conduct of his work. No assumption is made, however, that rules can be so arranged as to guard against every contingency.

Enforcement of rules is no less a duty than the promulgation thereof. Repeated and notorious violations will charge the employer with a knowledge of the insufficiency of the provisions made and the necessity of new regulations, or of additional superintendence. In the absence of steps to secure enforcement of rules thus violated it has been held that the employer has sanctioned their abrogation, and that they are no longer binding.

Besides the general rules by which the conduct of business is determined, instructions may be necessary either in case of abnormal conditions, or of the employment of inexperienced persons. The principle lying at the foundation of this duty is the same as in the case of providing safe appliances and safe workplaces, i. e., liability does not attach on account of the dangers of the situation, but for placing the employe in a situation of which he is inexcusably ignorant. Not every contigency is to be anticipated in the giving of instructions, but such only as are probable in the conduct of the business, and while the employe keeps within the scope of his employment.

CONTRACTS RELIEVING EMPLOYER.

Employe's Waiver of Right to Recover.—Efforts on the part of the employer to make his employes insurers of their own safety by the adoption of rules, or the requirements of contracts releasing the employer from liability will, generally, be discountenanced by the courts.

Thus it has been held that a contract executed subsequent to the employe's entrance on service, relieving the employer of liability, is void for want of consideration. On the other hand it has become more or less the custom among employers to require of an employe as a condition of employment the making of a contract relieving the employer from the liability imposed by law. In England it has been held that it is not contrary to the policy of the employers' liability act to waive the benefit of the same by contract, and that such contract is binding, not only upon the employe himself but also upon his representatives in case of death. In the United States it has generally been held by the courts that a contract made in advance, irrespective of statute, whereby an employe agrees to release and discharge his employer from liability for any injury he may receive by reason of the negligence of his employer, or of his representatives, is contrary to public policy and is, consequently, void. This principle has been announced by a national court as follows: "As a general proposition it is unquestionably true that an employer can not relieve himself from negligence by any contract entered into for that purpose before the happening of the injury."

In direct contradiction to the foregoing statement is a decision rendered in which it was held that where an employe, by special written contract made at the time he was employed, and in consideration of said employment, agreed "to take upon himself all risks connected with, or incident to, his position, and that he would in no case hold the corporation liable for any damage he might sustain by accidents which might result from the negligence, or carelessness, or misconduct of himself or other employes or persons connected with the corporation, or in the service thereof," such a contract, so far as it did not waive any criminal neglect of the corporation or its principal officers, was a legal contract and binding upon the employe, and in effect waived all his rights under the law. In other words the court held that it was legal for an employe to contract with his employer to relieve such employer of all liability in damages for injuries sustained.

Where the feature of relief benefits exist a new factor is introduced and the rulings are quite uniform in favor of the contract. In general the terms of the contract are, that the acceptance of benefits by the injured employe should operate as a waiver of his right of action at law against the employer.

RELIEF ASSOCIATIONS.

Briefly described, a relief association is an institution organized by a corporation designed to furnish money benefits, and often free hospital treatment, to employes of such corporation when they are disabled by accident or sickness, and to provide a certain sum of money for their families in event of the employes' deaths. The relief association's affairs are exclusively under the management of the corporation which contributes to its funds. In addition a certain proportion of the wages of each employe who is a member of such association is retained by the corporation and turned over to the benefit fund of the association. It has become the custom to include in the application for membership in the association the following or similar agreement on the part of the employe: "The said applicant agrees that, in consideration of the contributions of the said corporation to the

relief and hospital department, and of the guaranty by it of the payment of the benefits aforesaid, the acceptance of the benefits from the said relief and hospital department for injury or death shall operate as a release of all claims against said corporation for damages by reason of such injury or death." Many of these applications, in addition to the above agreement, contain the following: "And I, or my legal representatives, will execute such further instrument as may be necessary, formally, to evidence such acquittance."

This sort of an agreement (contained as it usually is in the printed application for membership which must be signed by each employe who desires to join such association, is evidently designed to relieve the corporation of its legal liability for damages for injuries which the employe might sustain, and at first thought seems plainly antagonistic to the principles of the Common Law and the provisions of the various statutes which prohibit contracts, and so forth, waiving the employers' liability.

Such agreements, coupled with the fact of the actual acceptance of aid from the benefit fund after receipt of injury, have frequently been set up as matter of defense in suits brought against corporations for damages for injuries. The results of the decisions of the courts of different states seems to be to hold such contracts valid. It has been generally held that while a contract by which an employer attempts to relieve himself from a future liability for injuries or death of an employe would be void as against public policy, and frequently as being in violation of statute, yet the agreements or contracts now being considered are not of that class, but are only contracts for a choice between sources of compensation for the injury, where but a single source of compensation existed prior to the making of such a contract; that such an agreement recognizes that enforceable liability may arise, and only stipulates that, if the employe shall prosecute a suit to final judgment against the corporation, he shall thereby forfeit his right of action to recover from the relief fund, and conversely. It is the final choice, the acceptance of one against the other, that gives validity to the transaction.

It will be observed that it is the acceptance of benefits from this relief fund which, by agreement, releases the corporation from a claim for damages. If the employe injured does not accept such benefits, but chooses to sue for damages, his right of action is unimpaired, and in no respect waived. It is not a question of whether a corporation, by contract with its employes, can exempt itself from suits for personal injuries sustained by its employes which were caused by its negligence; that, as a general rule, can not be done. The employe does not waive his right of action against the employer, in case the former is injured through the latter's negligence, by the execution of the contract. It is not the execution of the contract that estops the injured employe, but his acceptance of monies from the relief department on account of his injury after his cause of action against the employer, on account thereof, arises.

DEFENSE OF EMPLOYERS.

Employers can not be held as the insurers of their employes; they are liable, however, for the consequences, not of danger, but of negligence on their part in the event of a breach of duty to an employe resulting in injury to him.

Assumption of Risks.—As stated in a previous paragraph when a contract of employment is entered upon the law imports into the agreement an assumption by the employe of the ordinary risks incident to the employment, and of such other risks as may be known to and appreciated by him. This is said to be a term of the contract, expressed or implied, from the circumstances of the employment, and is commonly stated as the 'trade risk.' In this connection it might be advisable to outline the two classes of risks recognized by the judiciary and known as 'ordinary' and 'extraordinary' risks.

Ordinary Risks.—Ordinary risks have been defined as those that pertain to the employment after the employer has discharged his duty as to safe work-places, tools, appliances, and so forth, and which ordinary care on his part can well guard against.

Extraordinary Risks.—Risks which may be obviated by the exercise of reasonable care on the part of the employer are classed as extraordinary, and these the employe is held not to have assumed without a knowledge and comprehension of the dangers arising from the employer's negligence. If the dangers are patent, or are brought to the knowledge of an employe, his entering upon or remaining in service is presumed to have waived his claim against the employer for resulting damages. In the first place he will be held to have made his contract in the light of existing conditions; and, as to risks arising during employment, it has been said that if an employe continues to use a workplace, tools, appliances, and so forth, which he knows to be dangerous, he does so at his own risk, and not at that of his employer. It must appear, however, that the risk was actually appreciated. While a failure to notify the employer of discovered or known risks is construed as indicating the employe's willingness to continue to work while they exist, the risk is not thrown upon the employer by a mere notification not replied to by his promise to repair. If the alternative of continuing to work with the defective appliances, or of leaving the employment is offered, and the employe continues to work, he will be held to have assumed the risk. A promise to repair, however, can be relied upon only for a reasonable time, after which the risk will be upon the employe.

Where a specific direction from the employer, or other competent person acting as the employer's representative, ordering a temporary departure from the contractual lines of duty, the risks incident to the new employment are, in a sense, extraordinary, as the new order carries the employe beyond the contract of hiring and so, also, away from his implied undertaking as to assumed risks.

Contributory Negligence.—It is a general rule that when an employe suffers an injury through the negligence of his employer he is not entitled to recover damages for such injury if his own negligence contributed thereto. Under this rule where employes and employer have equal knowledge of the danger of the service and the means of avoiding it, and the employe, while engaged in the performance of his duties, is injured by reason of his own inattention or negligence, the employer is not liable; and, where the employe is told to do a particular thing and is not directed as to the time and manner in which the work is to be done—it being left to his discretion—he is guilty of contributory negligence if he does not use the safest means of accomplishing the work and is injured while so engaged, and cannot recover damages from the employer. But an employe's right to recover damages for an injury is not affected by his having contributed thereto unless he was at fault in so contributing. Likewise an employe is not guilty of contributory negligence if, when injured, he was exercising ordinary care to avoid injury, and discharging his duties in a careful and prudent manner, and the injury was sustained by reason of negligent failure on the part of the employer to exercise ordinary care for the employe's safety.

When a risk involves such a degree of danger that a prudent man would not assume it, the defense to an action by an inured employe is not that the plaintiff by his contract assumed the risk, but that he was, by his conduct, guilty of contributory negligence. It will be observed that the line is not closely drawn

between the two defenses, nor is it always easy to do, inasmuch as the facts in a given case might support either defense. Cooley (Torts, page 674) announces the rule as follows: "If the plaintiff, or party injured, by the exercise of ordinary care under the circumstances, might have avoided the consequence of the defendant's negligence, but did not, the case is one of mutual fault, and the law will neither cast all the consequences upon the defendant, nor will it attempt any apportionment thereof."

Contributory negligence is purely a matter of defense in action b employes' for damages resulting from injuries sustained during the course of their employment, and the burden of proving it is upon the employer who seeks thereby to avoid liability for such damages.

Comparative Negligence.—The attempt to impose a doctrine of comparative negligence has been declared unconstitutional. Primarily this doctrine favored an apportionment of the fault where, in the case of inury to an employe, if the preponderance of negligence seemed to be chargeable to the employe, to award damages in a corresponding amount. Conversely, where the negligence of the employer is great, and that of the employe but slight, the latter may recover The construction placed upon this doctrine of comparative negligence is merely a peculiar restatement of the common law doctrine of contributory negligence.

GENERAL.

The past few years have been marked by a rapid increase of interest in the question of the adjustment and distribution of the burden of the results of industrial accidents, the doctrine of compensation as distinguished from that of liability coming for the first time in the United States to any widespread support. Where the idea of the employers' liability controls, the employe is given a right of action against the employer in cases where injury from accident results as a consequence of the negligence of the employer, or of some one charged with the performance of his nondelegable duties; with this, however, the rule must be considered that where the injured employe contributed by his own negligence to cause the accident, such contributory negligence bars recovery. Ordinary risks, not due to the employer's negligence, but incidental to the employment, are held to be assumed by the employe and for injuries resulting therefrom no recovery of damages can be had. It is obvious that the only right allowed the injured employe under this doctrine is the right to sue which experience has shown to involve uncertainty, delay, expense, and the ultimate acquisition by the workman of only a fraction of the money actually expended by the employer in the way of defense and of payments on judgments.

The impossibility of securing to the workman the needed protection by a mere grant of right of action for injuries for which the employer can rightly be charged is evident from a consideration of the principles of law set forth above. The employer who is the agent of the public in the matter of production, should be charged with the duty of so administering industrial undertakings that the burden of the socalled "trade risk" shall fall on the industry at large, and not be concentrated on the weakest point—on the individual workman, disabled for service through the mere fact of his employment at the time and place of the occurrence of the inevitable accident, or on the widow and children of such workman, if the accident results fatally.

CONCLUSION.

Owing to the multiplicity of the statutes passed by the legislatures of the different states, together with the fact that they are all applied and interpreted by courts composed of many different individuals whose intellectual faculties do not all work in the same grove, and whose judgment, therefore, do not always coincide, and, also, to the further fact that in no two cases are the facts precisely the same, there is always an uncertainty as to the outcome in each particular action brought for the recovery of damages for injuries. For the above reason it is no doubt true that many cases are compromised or dropped altogether by employes rather than to incur the expense of a suit at law, and to risk the uncertain outcome thereof; and, on the other hand, many employers are put to much trouble and expense in deciding suits which never should have been brought, the employes having, as the results demonstrated, no legal case.

That this condition of affairs—this uncertainty as to whether the law affords a remedy—can ever be improved while the human intellect continues to be fallible, and the present line of legislation continues to be followed, is greatly to be doubted, and it is this fault of the law in its application which led to the radical changes in the plan of legislation which have been made by Great Britain, France, Germany, Belgium, Russia, and many other foreign countries, in their compulsory insurance acts and compensation acts against accidents to workmen.

Briefly, the idea of compensation is that of an award of a fixed sum for injuries for which the employment is responsible without the necessity of litigation, or the endeavor to determine the question of fault. It is frequen vided, however, that where an e is apparently grossly negligent, will be recoverable, and if the is willfully or grossly negligent, take nothing either by way of sation or otherwise.

Legislation upon the lines of the employer responsible for all of his employes, regardless question of the employers' neg and the system of compulsory in of the employes against accide adopted in foreign countries, given a trial in several states Union, but as yet the subject really become a national issue.

NOTATION:—(1) Cyclopaedia and Procedure.

When properly used, the ter applies to a banded variety of ch closely allied to agate. It is siliceous rock, and constitutes th ious onyx" of the ancients. The derived from the Greek for nai lusion to the wavy bands which the stone, and to its translucen of which characteristics it has mon with the nails of the hand. the term travertine are included tintc types of rock which agree sisting of calcium carbonate, or but which have quite distinct n origin, one being deposited by th of hot springs, mainly through th of conferva-like plants, and the o ing deposited from cold waters as a result of purely chemical These deposits are both known a tine, which is found wherever wat ly charged with calcium carbon over the surface. Much of it porous, or cellular in structure, this phase of deposit, as found al orifices of springs, the term "t "calcareous sinter" is applied. compact in texture the rock is of taking a fine polish, and as a term for both spring and cave the term "Travertine marble" is a priate designation. It is unfortun the term "onyx" has been ap these rocks, which are essential bles.

The necessity of having the concentric is obvious. In hand ening and even with some powe eners it is not uncommon to find the ends of the cutting edges pr 1-32 to 1-16 inch beyond the other manufacturers have effectually o this difficulty by entirely enclos bit under a heavy pressure whi being forged. When this is dor can be no question of the corn ing within a circle.

From Copper To "Gold Mines"

This space is reserved for the picture of A. F. Holden, the other eminent engineer who lent his name and gave his endorsement to the electrifying report on Alaska properties submitted herewith and which will be reproduced from month to month.

NOTED ENGINEERS JOIN BROKERAGE HOUSE IN A REMARKABLY PECULIAR PRESENTATION OF AN ALASKA GOLD MIRAGE.

Extract From Report of Messrs. Jackling and Holden.

We have considered the PROBABLE capital requirements for a capacity of 6,000 tons per day, which contemplates a hydro-electric power plant; mine development and equipment, including all the necessary living quarters, both at the Perseverance mine proper and at the mill, and driving the long adit tunnel. We BELIEVE that $4,500,000 will do this work.

Our BELIEF is that the substantially INDICATED ore body is about 4,500 feet long by 70 feet wide. The value of the 600,000 tons of ore THAT HAVE BEEN MINED FROM THIS BODY IN THREE DIFFERENT LARGE STOPES INDICATES that a recovery of at least $1.50 per ton can be made. We BELIEVE that there will be 75 cents per ton profit in this grade of ore. The Sheep Creek Tunnel, which will be driven on the vein as the main haulage level, will develop this ore body at an average depth of about 2,200 feet on the dip of the vein, or about 700 feet deeper than present developments.

The character of this vein is similar in A VERY GENERAL WAY to other large deposits of gold ore in the same vicinity in which the values at a vertical depth of 1,600 feet, or 2,000 feet on the dip of the vein from its apex, are practically the same today as they were on the surface, and have been throughout the development of THE DEPOSITS IN QUESTION. We visited these mines and saw THEIR deep levels, and, if there is any inference to be drawn from the continuity of THESE ore bodies, WHICH ARE NOT, HOWEVER, ON THE SAME VEIN AS THE PERSEVERANCE, one MIGHT BE TEMPTED to say that there is a PROBABILITY of ore 2,500 feet deeper than the so-called Sheep Creek Tunnel which we contemplate driving, BUT, while the PROBABILITY is there of the vein and values extending to great depth, THERE IS NOTHING TODAY TO WARRANT ANYBODY IN STATING THAT IT IS A FACT THAT SUCH WILL BE THE CASE.

There are substantially 50,000,000 tons in the ore body we consider definitely INDICATED. There is a PROBABILITY of another 2,000 feet to the east of the 4,500-foot ore zone previously mentioned, which, from surface indications, would seem FAIRLY CERTAIN to contain ore. Beyond this is some 1,800 feet of the vein concerning which we have NO FINAL OPINION one way or the other. AS WE VISITED NO WORKINGS OR OUTCROPS from which we could secure sufficient data to form accurate deductions. While we cannot at this time state that there IS ore here, there were several SMALL MINES worked almost at the extreme east end of the vein on this property, which INDICATES that this 1,800 feet will undoubtedly produce considerable ore and PERHAPS LARGE QUANTITIES. If we do not consider this in the PROBABILITIES, it is certainly well within the POSSIBILITIES.

This letter is based solely on a consideration of $1.50 recoverable value as ore. If one should figure on lower values, assuming 75 cents as the total cost of mining and milling, the tonnage now indicated in INDEFINITE, but certainly enormous. We BELIEVE that sound mining business will INDICATE that for the installation now proposed and for an operating period of, say, two years, IT WILL BE WISE TO CONFINE OUR WORK TO THE HIGHER GRADE ORE. There can be, in our opinion, little doubt that at some time in the comparatively near future A VERY MUCH LARGER PLANT than the one now proposed will be installed for the purpose of working a larger tonnage of the normal grade ore we now EXPECT will be developed, or of utilizing the apparently vast quantity of lower grade material.

The INDICATED earnings from the installation now contemplated are approximately $1,500,000 per annum. Considering the TREMENDOUS POSSIBILITIES, and we use the word "tremendous" advisedly, we BELIEVE this mine to be a LEGITIMATE purchase at $15,000,000 and A BARGAIN at $12,000,000, provided that, in both cases, a development, equipment and working fund of $4,500,000 is made available. You must understand and appreciate that we do not consider the 6,000-ton per day development and installation as the ultimate possibility of the mine or anywhere near it. The POSSIBLE tonnages of ore INDICATED in this property APPEAR to be greater than any vein deposit WE know about.

We EXPECT the first unit of the new mill to be in operation on or before January 1st, 1915. We really BELIEVE that, barring accidents, the time MAY be made July 1st, 1914.

(Signed, D. C. JACKLING,
July, 1912. A. F. HOLDEN.

In driving the Laramie tunnel in Colorado, the average depth of hole was 17½ feet; a stick of 60 per cent powder was placed in the bottom of the hole; then the primer, on top of which five sticks of powder were used except in the case of cut holes, each of which were loaded with three or four extra sticks. The three lifters were loaded to the collars in order that the broken ground should be thrown as far as possible from the face.

One of the papers the other day said that the allotment of "$5 paid" stock in the Alaska Gold Mines Company had been made by Hayden, Stone & Co. Wonder how much of it the "bankers and brokers" of Salt Lake got?

GEOLOGY AND MINES OF HIGH GRADE DISTRICT

By WILLIAM H. STORMS.*

High Grade mining district, which has the past few months attracted considerable attention from prospectors, and investors as well, is situated in Modoc county, California, and extends a short distance northward across the state line into Oregon. It is on the summit of the Warner range of mountains which lies between Goose lake, on the west, and Surprise valley on the east. The entire district is in a region of volcanic rock—andesite and rhyolitic flows and tuffs, forming the central portion of the range with later flows of basalt and agglomerate on the eastern borders.

The history of the district extends back for many years, but the entries are few. At one time the government maintained a military post in Surprise valley, known as Camp Bidwell This place, now called Fort Bidwell, is about twelve miles southeast from High Grade, and is near the eastern base of the Warner mountains. Soldiers from the fort, and others, found gold in the Warner range many years ago, but the principal prospector was a man named Hoag. He did considerable work at the surface on various claims, and the district came to be known by his name. In 1905 new discoveries in these mountains resulted in renewed interest in the possibilities of the region, and then, for the first time, some real development was accomplished, which has since been followed by a much more general interest in these prospects and the renaming of the district, it being now known as High Grade. It is needless to say that this newest name for an old district was suggested by commercial considerations. Nevertheless, there is high-grade ore in several mines of the district.

The geology of the district is comparatively simple when viewed in its broader features, but somewhat complicated here and there locally. The Warner mountains consist of a thick series of volcanic flows and sediments which form a portion of the great volcanic plateau which covers all of Modoc county, a large part of Shasta and Lassen counties, and extends northerly and easterly into Oregon and Nevada. The general history of the Warner range, as indicated by exposures in that region, shows that a vast mass of nearly horizontal volcanic strata, chiefly andesites, rhyolites, and tuffs, were cut by a great fault which skirts along the east shore of Goose lake. In fact, it looks as thought Goose lake were the direct result of the faulting of this region. Israel C. Russell has written a most interesting description of a number of these faults which occur in southeast Oregon and extend southward into California. Several of the valleys formed by the faulting of the great volcanic plateau are the sites of lakes; others have been filled with detritus and are now fertile valleys. Along the east side of the Goose lake fault the volcanic beds were lifted 2000 feet or more, the entire series dipping 10 to 20° to the eastward. Russell describes a similar fault along the eastern base of the Warner range in Paradise valley, so the Warner mountains as a whole represents a great fault block, lifted above the surrounding valleys, the strata having a general dip to the eastward. In the central portion of this range the rocks do not all lie so nearly flat, but are found more or less disturbed, at some places standing in vertical position. There are in the central area several minor faults which have divided the district into a number of fault blocks. It is in the vicinity of these faults that the principal mineralization has taken place, along zones of brecciation, or following fissures in the breccia, which strike in various directions, though usually north-south and east-west. Where these fissures have intersected each other there has, in some places, been an enrichment, and it is the occurrence of this rich ore that doubtless suggested to the miners the name of the district—High Grade.

There is evidence to prove that after the uplift of the range and the formation of the brecciated zones and fissures in which the gold-bearing ores are now found, there was a long period of erosion, found planed off in some localities on the as the strata of rhyolites and tuffs are higher hills, and the gentle slopes to the northeastward, which at first might easily be mistaken for dip-slopes are really the result of erosion. The theory of a period of erosion at that time is proved by the fact that the later flows of basalt and andesite with their accompanying tuffs, overlie the adjacent hills to the eastward, tongues and remnants of the basalt being found lying on the older rhyolite and tuff, which would be impossible had the upper rhyolite not been removed by erosion. These later volcanic rocks have no connection whatever with the mineralization of the district, but it is in ing to know that the ore-bearng tions extend eastward and northw neath the more recent volcanics admits the possibility of the exten the known mineralized zone in tha tion. I was shown some ore, a s brecciated rhyolite, from the ea of the Fort Bidwell range, that m sembled some of that found in th Grade district. For lack of tim not visit that locality. Since the of basalt flows the entire region h subjected to tremendous erosion, cated by canyons 3000 feet deep the top of the basaltic plateau.

The accompanying sketch, Fig northeast-southwest cross-section Grade district, drawn through mountain, one of the highest po the district. It will give a gener

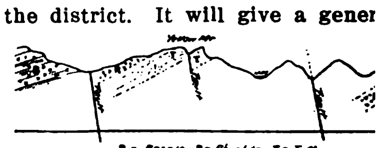

Fig. 1.—Cross-Section at High C

of the structural geology of the as a whole. The time at my was not sufficient to admit of a examination of the entire region tail, so at this time generalizatio can be submitted. The sketch m 2, shows the drainage of the count on it are also indicated some of th which appear to have important on the structural features of the and incidentally on the minerali

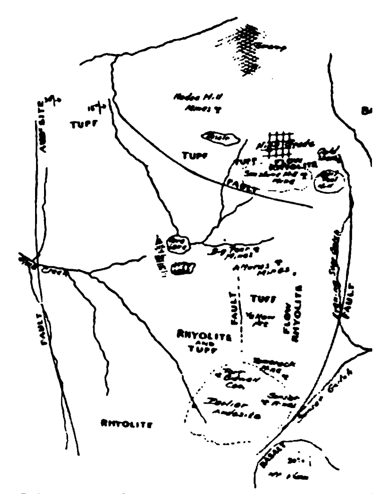

Fig. 2.—Sketch Map of the High District.

I did not ascertain the natur cession of all of the rocks in the turbed area lying in the western the Warner range, but know tha rocks are principally white flow- and white rhyolite-tuff. These c the greater part of the front c range. About half way between t of the mountain, and High Grade I believe the rocks have been

* State Mineralogist of California in Mining & Scientific Press.

me of the rhyolite and tuff found front range appears to be repeated eastward of this fault, if it actual-ts This should be verified, as the ne may be said to be suggested by aphy rather than by actual evi-

However, about half a mile east electric light plant on Pine creek, rupt facade of purplish rhyolite several hundred feet above the bot-f the canyon, with a steep talus base. Its course is a little west th and east of south. Bluffs and of what appeared to be the same nay be seen for a distance of a and a half or more, occupying a · position on adjacent hills, and ct line with the main palisade on orth side of Pine creek. This I to be, in all probability, the main of bringing the rhyolites of the range once more to the surface in cinity of High Grade. If this fault y occurred it must have a throw ing 2500 feet

principal rocks of the High Grade t are a white flow-rhyolite at the nderlain by a bed of variable thick-f white rhyolite-tuff, usually buff l near the surface, and this in s underlain by purple porphyrite e. These rocks extend from the e northerly end of the district. they pass under the more recent , to the south end, at the Sugar and Mountain View mines of the Bidwell Consolidated group. South-rom there the rock is principally cient andesite of very fine texture, g from bluish-black to greenish-and grayish-black in color. I did e a single intrusive dike in this n of the range, though dikes of cutting the tuffs and rhyolites of Cottonwood creek are numerous. latter are five to six miles south-f this district. In that vicinity, on ear the Snyder ranch, are also fis-eins containing gold, some of them very encouraging prospects.

re are several types of ore deposit h Grade district. The most com-re zones of brecciation, highly sili-and auriferous. These occur in yolite and tuff, and also in the · andesite at the south end of the t. A second type is that of rather fissure veins cutting at high angles h the zones of brecciation. In some mines these fissures run at nearly angles. At the intersections rich s been found.

ird type occurs in the form of near-: sheets of rhyolite or tuff, highly ed but with little or no brecciation, auriferous. These may be con-d as zones of impregnation. Still r type is the fissure vein occurring outside of any zone of extensive brecciation. This latter is represented in the North Star mine, where a fissure, varying in size from an inch or two to three feet or more, runs through the earlier andesite. Some of this rock contains payable ore; some of it is low grade. The quartz is white and sacchaoidal, and shows some blue and green copper carbonate. This is said to be the discovery vein of the district. It is developed by several hundred feet of workings. It is at present held under lease and option.

The Sunset workings, consisting of about 800 feet of development, are entirely in the earlier andesite, which here is found sheeted by pressure, the structure making it appear like a nearly vertical dike, or intrusion. I think that a fault of considerable displacement passes just east and south of this locality, its course being denoted by the neighboring canyons, Evening Star gulch and Sunset gulch. On the opposite side of this canyon and about 100 feet south of the Sunshine mine, the basaltic strata of Mount Vida are seen to have a northwesterly dip, which is opposite to the general dip of the formation to the northward. This fact appears to lend color to the probable existence of the fault here referred to. This fault has a curving strike the concave side facing the west. Unfortunately, at the several points where these faults pass through low saddles, in every instance examined, the evidence of their existence is obscured by low flat surfaces, covered by deep soil, or piles of rock.

The Fort Bidwell Consolidated property comprises several claims. The Mountain View, one of these, occurs in a zone of breccia at the contact of the earlier andesite with the rhyolites, whereas the Sugar Pine, another of its properties, is wholly is the rhyolite.

The Shasta View, adjoining the Mountain View on the southwest, is wholly in the earlier andesite. Both of these properties have some high-grade ore, and much that is too low in value to ship, but which is still a good grade of milling ore.

The Fort Bidwell company is operating a 10-stamp mill. The ore is delivered to the mill from the Mountain Vew by drift and tramway on the mill-level, and from the Sugar Pine, which is on the opposite side of the divide, by aerial rope-way. The workings of these two claims are to be connected, when all ore can be sent to mill through the main adit, which will prove a great advantage, as the deep snow in winter interferes with the operation of the rope-way.

The Alturas company's property is on the east slope of Yellow mountain, and is wholly in the rhyolite. The principal shaft is 105 ft. deep. Hoisting is done with a horse-whim. In this shaft a shoot of ore in purple flow-rhyolite is being developed. This ore contains more sulphide (pyrite) than was observed in any other mine in the district. Yellow mountan slopes from its crest, at 10 to 15 deg. eastward for a distance of a mile, when it plunges steeply downward into Evening Star gulch. Along the rim of this sudden descent, and on the flat back of it, are a number of promising prospects. Some of these belong to the Alturas company, others to the Seven Lakes company, while still others are held by the locators. Among these latter is the Dandy Fraction, which makes an encouraging surface showing. These workings are mostly in the brecciated flow-rhyolite, though a few are in the tuff. Some of them are of the impregnation type. On the northeast side of this rim considerable work has been done on a claim called the Mountain Sheep, but the mine is idle, due to pending litigation. The cause of the contention lies in the fact that the Mountain Sheep conflicts with three other locations, having been laid diagonally across them.

To the eastward of Yellow mountain and between it and Camp High Grade is the property of the Big Four company. The ore deposits here are of several types, including practically all of those found in the district. One of these is that of a flat sheet of much silicified rhyolite which shows little evidence of brecciation. This ore is being treated in the company's 5-stamp mill, with good results, so I was informed. In this property considerable work has also been done on a nearly vertical fissure vein, in which high-grade ore was found.

The Sunshine, Yellow Jacket, and Last Dollar mines are on Sunshine hill and are practically in the camp of High Grade. The ore here occurs mostly in brecciated masses of rhyolite with north-south and east-west fissures cutting the zones of brecciation. It is at the intersection of these fissures that the rich ore has been found. The first shipment of 10 tons carried over $250 per ton gross value. Another shipment was ready at the time of my visit. On the Sunshine hill there are at least three separate zones of brecciation, and there may be others not as yet developed. The Sunshine claim has been divided into a number of blocks, nearly all of which had been leased, and the lessees were eagerly working to develop their several holdings. To the eastward on a neighboring hill the Gold Shore claim resembles the Sunshine, having the same rhyolite breccia and silicification, which is an

accompaniment of the auriferous ores of profitable grade everywhere in this district.

On the plateau north of High Grade is a group of claims owned by the Modoc Mines Co. A shaft had been sunk to a depth of 60 ft. at the time of my visit and some excellent ore found. The ore here is in the brecciated rhyolite. This company has built a substantial headframe and has a well equipped steam-hoist.

There are numerous other claims scattered throughout the district, but which had so little development that no particular mention is made of them, though some of these show good prospects in gold. I observed fissures in various parts of the district, in which the rock was much kaolinized and stained by iron oxide, but all of the occurrences of this character that came to my attention were low in gold. There may be exceptions to this, but I did not see them, if there are any.

There are some striking features in the topography of this district, which are due principally to two causes, first, minor faulting, and second, climatic conditions. Naturally the first cause has left the more noticeable results as observed in the steep slopes on one side of the hills which are probably fault scarps modified by erosion. There is undoubted evidence of the former presence of small glaciers, as indicated by the kames, moraines, small lakes, and swamp holes, in the canyons of the region. Cave lake, Lilly lake, Opal lake and others are all of this origin. Since the glacial period erosion has progressed so far as to destroy practically all evidence of its former existence except the features above described.

Another pronounced feature in the topography is in the so-called "rock piles." These are generally the locus of ore disposition. All the ore of the camp so far as I observed, is extremely silicious. The already dense rhyolites, in the zones of fracture and brecciation, have been rendered additionally hard by the infiltration of silica, and these zones being more resistant to erosion have a tendency to stand up in wall-like masses above the surface. These walls have been attacked by alternations of freezing and thawing, and the result is, as seen, a breaking down of these hard outcrops and the scattering of the fragments, large and small, over a considerable area in the immediate vicinity of each occurrence. This has made the development of the ore-bodies rather backward, as so much superficial work was required and is still being done to find the gold-bearing rock in place. The prospector first finds "float" ore in the pile of loose boulders. He then decides, as well as he can, upon the most likely point to find the orebody in place. The loose rock is often from 10 to 30 ft. in thickness and it requires considerable preliminary work to reach solid rock. In most places an adit run from some place on the mountain side would best solve the problem, but these lessees want to find their ore and stay with it, which from their point of view, is good policy. Owing to these peculiarities, the hardness of the rock, shortness of the summer season, and lack of present liberal financial aid, it will probably be another year before much more is known of the geological conditions obtaining in this district, than is indicated in this description, for the work of development will proceed slowly at first.

The metallurgical problem is not a difficult one. At present, simple amalgamation is the only treatment given these ores, but the percentage of value thus saved is sometimes discouraging. The gold is extremely fine in most of the ore, though the richest ores occasionally contain much visible gold. I believe that the cyanide process will satisfactorily solve the metallurgical difficulties. The only sulphide observed was pyrite, with a single exception, which was an occurrence of mispickel. Copper also occurs in a few places, but in small amount. Generally speaking, so far as developed, iron sulphide is far from abundant in these mines, the gold appearing to be associated rather with the secondary silica than with sulphides of the base metals. Most of the gold is accompanied by silver, some of the bullion running as low as $12 per ounce. Most of the ore affords excellent examples of that condition so interestingly described by Franz Posepsy as "crustification."

The district is an ideal summer camp. It has the advantage of abundant timber and water, and is but nine miles from the railroad, at New Pine Creek. Deep Creek, which heads just north of High Grade will furnish abundant power which can be transmitted into the district. So, on the whole, High Grade may be said to possess the elements of success. The energetic men who are at present interested in the district, and who, by the way, are mostly from Colorado, where they do not look upon the deep snow of winter as an insurmountable obstacle, will, without doubt, make the most of the situation at High Grade and achieve the success to which they are entitled. At present there are no saloons in High Grade, and little or no gambling, nor is there either church or school, but the people of the camp are optimistic to a degree, and most of them have calloused hands, which speaks much for their faith. A portion of the district—that at the north end, is on "school land," section 36, which was purchased from the state. The rest of it is in the forest reserve.

It has bees repeatedly stated by some of those interested, that High Grade district is "another Cripple Creek," and that "it will eclipse Goldfield." These and similar comparisons with noted mining districts have been made. Geologically it bears no resemblance to either Cripple Creek or Goldfield. The mineral deposits are only in a remote way similar to those of Goldfield, and very unlike those of Cripple Creek. Each mining district must stand or fall upon its own intrinsic merit. High Grade will, without doubt, produce some profitable mines, but how many remains to be determined by development and ore treatment. Already the newspapers are beginning to contain statements attributed to me, which I never uttered. The above description of the camp is a truthful one, and presents the district to the mining world as I saw it during my visit of a few days. The work was a reconnaissance at best, and the statements made are subject to change as development proceeds and the district becomes better known.

That every claim, or group of claims, in High Grade district will become profitable, I do not believe, but the superficial showing certainly justifies energetic prospecting and that, too, in some places where little has as yet been done. There is a probability that the development of the surrounding country will extend southward to Mount Vida and beyond, and some encouragemest has already been given prospectors in that direction. I did not visit that locality, however, and know of it only from the description of those interested there, who showed me some ore which they said came from that locality.

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Pumps often give trouble because of an unequal pressure within the steam-chest acting on the area of the steam valve or the valve stem. As the valve stem extends through only one side of the steam chest there is a constant tendency to blow it out. To overcome this trouble the use of a coil spring between the bracket and collar has been recommended. This spring should be given sufficient tension to counter balance the action of the steam acting on the area of the valve stem. While the action of the steam is to force the valve stem out of the chest, the spring forces it in again and therefore the forces are neutralized and the valve stem stays where it is left by the tappet arm.

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The tungstate of manganese is known as huebnerite.

Mines and Methods

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Mines and Methods

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CONTENTS:

A feature of the strike at Bingham that has caused not a little mental calculation on the part of those who read the daily statements put out by the Utah Copper management is the vast amount of ore that is being handled by a comparatively few men. The other day, when the company's report to the papers claimed that about 300 men were at work, it was declared that about 12,000 tons of ore had been mined and shipped to the company's mills. When this item was written the company was claiming that it had about 1000 men at work and that 10,000 tons of ore was being daily delivered at the mills. When the strike started, on the 18th of last month, it was said that over 3500 men went out at the Utah Copper mine alone. What those who are figuring are trying to get at is this: If 300 to 1000 men can now produce ore at the rate of 10,000 tons a day, or one-half the capacity rated before the strike, why was it necessary to employ 3500 to mine 20,000 tons? One of two things seems certain—either the company is not doing what it claims it is now doing, or else things were being run in a mighty slip-shod and extravagant fashion before the strike.

ALASKA GOLD MINES FIZZLE

Well, we certainly baited right last month, for it was no time, hardly, after the September issue of Mines and Methods made its appearance in the East until we got a "raise" from the "sharks" who are (or were) claiming such great things in the exploitation of the Alaska Gold Mines Company—that proposition so tactfully (?) described by those EMINENT engineers, Messrs. D. C. Jackling and A. F. Holden, in their "report," which we reproduce again this month. Don't, for the love of Mike, accuse us of a purpose of "rubbing it in" by continually reproducing this truly remarkable document, because that would not be fair to the eminent authors of it. That "report," apparently, was compiled as a response to the encore demanded by those who for years have been profiting by the exploitation of the claimed engineering prowess of the first signer and the known and acknowledged ability of the other, and the only thing about it that baffles our comprehension is how the second signer of the "report" was mesmerized into attaching his signature. But, seeing that it is there, join with us in what ought to be counted as a laudable desire to finally witness the placing of life-sized busts of these masterful engineering craftsman in the world's hall of fame.

In the last issue of this journal we did what we could to help out the proposition offered by the sponsors of the Alaska Gold Mines Company by going somewhat into detail concerning features of the company's undertaking that were evidently overlooked in the "report" referred to. And while the exploiters probably had in contemplation a different method of convincing the world that Manager Jackling could easily wrest a profit of 75c. a ton from $1.50 ore BELIEVED to be scattered through a precipitous, glacial, mountainous mass of badly shattered slate and greenstone in which engineers for the Geological Survey have declared it would be impossible to mine the ore without also mining the waste material, we tried to make it plain how advantageous it would be to them if our readers would take on some of that "$5 paid" stock at $9.50 to $10. They won't call on you for the other $5 until next June and maybe by that time they will be ready to give you a crack at another issue of installment stuff that will look like gold nuggets, freshly plucked for the occasion.

Excuse this rather facetious diversion. What we started out to call your attention to is the following half-hearted acknowledgement that the scheme has proven much of a fizzle so far. Of course this admission is screened as much as possible by silly boasts in one place, boosts for the promoters in another and apologies elsewhere, with here and there a reference to what mythical "mining people in Alaska" and others BELIEVE can be done. We are reproducing the whole article, just as it appeared in the publicity journals in the east whose utterances are controlled by the promoters of the game, and copied by the claquers here. Read it carefully and then, if you are able to exercise calm judgment, we are satisfied you will be willing to let the promoters continue to hold the stock:

The 100 per cent premium put on Alaska Gold Mines so soon after the subscription and allotment by Hayden, Stone & Co. is causing profound interest throughout the mining world. The market seems to be well established around $10 and is perfectly open and free and the people who are turning in the original bonds on the property are taking payment therefor in stock at $10 per share. This price is not really 100 per cent premium. It is only 50 per cent premium, because the subscription price is $10 and the first payment $5.

Read the above paragraph again and let it soak in.

The circular of Hayden, Stone & Co. is remarkable in its indefiniteness, although the apparent effort of the financial statement was to be most definite. Simply stated, the fact is that when the bonds of the present company are taken up, the company stands with 750,000 shares issued for $10 per share cash, or $7,500,000. Of this, $3,000,000 is paid for the property and $4,500,000 goes into the treasury for equipment and development of the property.

Some admission in the first two lines of the foregoing paragraph. See the "report."

This is the real secret of the enterprise. The weakness of most mining promotions is that more is paid for the claims of the alleged mine than is raised to really make the mine. In this case Hayden, Stone & Co. insisted that the purchase price should be rock bottom with no profits or commissions to the promoters except that the bankers should receive banker's commission on the subscriptions. The promoters in the enterprise have got to look for their profits on the same basis as the subscribers, the only difference being that they had priority in allotment of stock at the same cost as other subscribers, $10 per share, one-half down.

So, when the promoters sell "$5 paid" stock to you for $9.50 or $10, they are doing fairly well, are they not?

Another remarkable thing about the promotion is the modesty of the claim as to the richness of the ore. While the Alaska Treadwell, across the Gastineau channel, with the largest gold mining equipment in the world, is reporting an expense of $1.52 per ton as its total cost of mining, milling, treatment and all overhead charges, the Alaska Gold Mines makes a claim of only $1.50 per ton recovery. The Alaska Treadwell made a recovery last year of $2.35 per ton from ore assaying $3.07.

That shows the fraud of this new promotion clearly, does it not?

The Alaska Treadwell, however, is raising ore from under an arm of the Pacific ocean and from a vertical depth of more than 1000 feet. In fact, the mine is now opened under the ocean to a vertical depth exceeding 1400 feet.

On the other hand, the Alaska Gold Mines company is largely an overhead stoping and caving proposition in which the mining saving may be 40 to 50 cents per ton. The operations will be on a very large scale. The value of the ore has been put at a minimum, according to other Alaska people, who believe there will be much ore running $2 and above in these claims.

If, therefore, there is any deficiency in the estimated cost of treating this ore it may be somewhat made up by increased value in the ore. Mining people in Alaska in no way identified with this property believe that both estimates of the value of the ore and the cost of the treatment, are unduly low.

As the Alaska Treadwell treats 5000 tons a day under 1000 stamps, gold mining people believe that, even with the mine overhead instead of underneath, it will be very difficult to cut the Alaska Treadwell's costs of handling a ton of rock in half, or to goodly increase the efficiency that has been reached in the Alaska Treadwell after thirty years' work.

We thought something like that ourselves.

However, as the German banker once said, "Everything can be improved." The people who manage the Alaska Gold Mines have made the greatest record of low operating costs ever seen in the copper field and have demonstrated, through some years of opposition and criticism, that they were right in their predictions of low costs in handling rock on a large scale in the Utah Copper mine. In fact, backed by the Utah Copper mine record their estimates of cost are entitled to as much weight as is the record of the Alaska Treadwell,.

Lets see; the Utah Copper claims to mine a ton of ore for 86c. and it saves nearly, if not quite one-half of the copper content in milling. That will be a fine record to make on $1.50 gold ore.

A few years hence the mining world will be on the qui vive to see how close the Alaska Gold Mines Company comes to an operating cost of 75 cents per ton. Considering that Alaska has geologically a very much larger gold bearing area than was ever uncovered in South Africa, the eyes of the whole world will in due time be turned to the Alaska Gold Mines Company and the Juneau gold belt.

The successful flotation and the handsome premium placed upon Alaska Gold Mines shares is bound to be much more far reaching than State street or Wall street. If the success of Utah is duplicated in Alaska Gold Mines the gold mining interests of the world will be more affected than have been the copper mining interests by the phenomenal record shown in the Utah porphyries by the same management.

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It's a safe bet that Governor Spry and Colonel Jackling wish that the election was over.

"Mine and Methods Extemporizes"

From Deseret News, Oct. 2.—It was learned this morning that the recent visit of Allen H. Rogers, a New York engineer, to the Ohio Copper Company several weeks ago was for the purpose of making a number of mill tests for F. Augustus Heinze. Mr. Rogers has done this kind of work a number of times for various other companies in the West and at one time made mill tests on the Boston Con., as well as the Utah Copper.

When the Bingham Review published an account of Mr. Rogers being in camp and examining the Ohio Copper, it was stated that it was supposed that he represented Hayden, Stone & Co. The opportunity was seized upon by a periodical published locally to make a story that the Utah Copper was about to acquire the Ohio Copper. Utah Copper officials, when asked about the story, flatly denied it.

It was charged in the article that the Bingham Review was owned by the Utah Copper. This was flatly denied this morning by the three persons interested in the paper and at the Utah Copper office. —Bingham Review, Oct. 4.

As indicated in the credits given for the item quoted above, the Bingham Review culled the item from the Deseret News. The funny part of it is that the scribe who supplied the News with the story is also one of the editors of the Bingham paper. This item charges Mines and Methods with saying that because Engineer Rogers was supposed to represent Hayden, Stone & Co, the Ohio was about to be sold to the Utah Copper Company. The writer of the foregoing item, of course, knows that he is not telling the truth, as will everybody who read the article in Mines and Methods last month. What we had to say was not alone predicated on the fact that Mr. Rogers might be working for Hayden, Stone & Co., but on that statement and the following remarks from the Bingham Review, which we quoted: "On account of the close association of the Utah Copper with the firm of Hayden, Stone & Co., it is pointed out as possible that the company will take over the Ohio Copper Company." Of course, if the News and the Review had wanted to be honest in the matter they would have acknowledged that it was the Review and not Mines and Methods that drew the conclusion complained of.

But all that is unimportant. The main thing is that "Utah Copper officials, when asked about the story, flatly denied it"—therefore, to use present election campaign parlance, the Bingham Review was a "liar." But we have reasons for still believing that the Bingham Review was not wrong. Had it been, the Utah Copper officials would not have bothered their heads about it; and the reasons why we believe that Ohio Copper IS destined to become a part of Utah Copper, were plainly stated last month.

Now, in reference to the last paragraph of the item quoted at the head of this article. We did not say or charge that the Bingham Review was owned by the Utah Copper Company. What we did say was that the paper was LOOKED UPON as the company's personally owned mouthpiece. And so it is; and if the company's interests do not own it they are lucky, that's all, because its service could hardly be better if it was paid for.

In the meantime, Mines and Methods stands pat on everything it said last month concerning the possibilities of a sale of the Ohio and the Mascotte tunnel to the Utah Copper Company.

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STRIKE SETTLEMENT ABOUT DUE

At this writing it looks as though the strikes at Bingham and Ely, Nevada, may be settled within a few days. During the six weeks that the contest has been on very little trouble, considering the great number of men concerned, has occurred. Some of the "fighting deputies" tried at different times to precipitate trouble, going to the extent, on one or two occasions, of shooting at strikers and beating them over the heads with guns and otherwise attempting, according to reports from onlookers, to "start something." On the other hand, yesterday morning, (the 25th), men reported to be strikers fired on a squad of workmen and "deputies" at the United States company's mines in which two or three workmen and one deputy were wounded. Inside of a few minutes hundreds of armed deputies and guards were in pursuit of the offenders and, while the entire day and night was occupied in a search for them, they were not apprehended.

We can not believe that the leaders of struggle at Bingham, on either side, are responsible for this outbreak, because day after day word from camp has been to the effect that no serious trouble was apprehended; that the strike leaders had been taking extreme precautions to prevent any of their numbers from committing acts of violence of any description. It seems, therefore, that the trouble of yesterday was more the result of too much display of force and authority on the part of ambitious "peace officers" than anything else.

As negotiations for an early settlement of the strike at Ely are under way, the belief is today that yesterday's regretable affair will not interfere with an early agreement in Utah, particularly as recognition of the Western Federation of Miners as a condition has been withdrawn.

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BELLINGER IS POPULAR

That Mr. H. C. Bellinger, formerly at the head of the metallurgical engineering staff of F. A. Heinze, is highly thought of at Cobar, New South Wales, where he has been general manager of the Great

r mines and smelters for the past years or more, is shown by the fol- ng from the Cobar Western Age of ember 14:

Cobar folks will rejoice to know the respected and genial general ager of the Great Cobar, Limited, is tly to have a holiday. Also, it is safe y that all will wish him a pleasant while away, and that he may return benefitted by his trip. As the head leading spirit of such a stupendous as the Great Cobar Co., Mr. Bellinger busy man, and he is, after four years' nuous grinding at the mill, justly en- to his four months' spell.

w other men in his position could steered the great undertaking safely gh the troublous times of the past years as he has done and yet retain confidence of both his employers and oyes. His cool and calm tempera- , coupled with his great tact, has en- him on more than one occasion to labor troubles, while his at all times l and kindly manner to the men has him extremely popular with all engaged on the mine, from the in- ficant nipper to those in the highest rity. At all times courteous, ever to listen to any complaint, and al- willing to redress a legitimate ance if possible, he has won such an nt of esteem from those placed un- him that falls to the lot of a few ted in similar positions. It is no geration to say that there's not a or boy on the Great Cobar mine but be pleased to hear Mr. Bellinger is t to have a rest; but they will be more pleased to know that his ab- from Cobar will be only temporary. d Mr. Bellinger's popularity is not ned to the mine employes alone. If only away for four months, Cobar miss him. An excellent boss and a ble manager, he has also proved him- a real good citizen. Notwithstanding many duties and the great calls on time entailed through his position as rintendent of the greatest copper pro- r in Australia, Mr. Bellinger never ked his duty as a townsman. No er what movement was mooted hav- for its object the advancement of the ests of the town, he was ever ready ive a helping hand; while the con- of his purse were always available ny deserving cause. A sport, a gen- an, and real "white" to the back- , is it any wonder the people of this should rejoice that Mr. Bellinger is ave a well-earned rest. May he re- strengthened and vigorous, so that may, when he comes back, in time e his great ambition to make the t Cobar, Limited, a dividend payer.

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udging solely from the action of the er metal market during the past six s there certainly has been a great mulation of hidden copper some- e. It was loudly proclaimed imme- ly following the strike at Bingham Sept. 18), that the curtailment of t would at once result in the rapid nce of copper metal prices and that ucers would have a hard time to nt "a runaway market," much as a happening was to be deplored. er mining stocks also were to soar ard and join in the runaway mar- but they have not done so and pro- rs are seemingly glad of the chance et rid of some of the accumulated l and thus prevent a break in price was nearly due when the strike was d. What a lot of brazen frauds these rn market dopesters are, anyway!

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the figures given by the daily press g the past month are to be given credence—and it is hard to believe that the daily press here would tell the truth if it were possible to avoid it—the Utah Copper Company is now maintaining an army of "deputy sheriffs" totaling 300 or more. The sheriff has assured the public that the county does not have to pay these men and when anything happens at camp involving the sheriff's force in any way, a prompt denial is made that any "regular" deputies were concerned. By what authority the sheriff swears in "deputies" for whose acts he is not in any manner responsible is a feature of the industrial struggle at Bingham that has not yet been made clear. And what is the governor doing to allow it.

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In a recently promulgated statement the Guggenheim Exploration Company places a value of $23.50 a share on its 404,504 shares of Utah Copper stock. Some difference between what they seem to consider it worth and the price at which it is quoted on the New York Stock exchange by the "laundrymen" who handle it. Wonder if the Guggenheims right now would not be willing to take $47 a share for all they own? If you think not, try 'em with a real cash offer.

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General Manager D. C. Jackling, of the Alaska Gold Mines Company, is having a $300,000 yacht built on Puget Sound. It is to go into commission next spring and, according to the information supplied by a local paper, will be used mostly for business and pleasure purposes in Alasakan waters. We had an idea that Sheep Creek was unnavigable, but possibly we are mistaken. We respectfully suggest the name of "Aurum" for the new boat.

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Right on top of the advance of wages in the camp of Butte came the announcement that the Amalgamated Copper Company had increased its dividend rate from 5 to 6% per annum. Some managers are the men in control of the mines of Butte.

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HERE IS YOUR CHANCE

One of our valued subscribers in Bisbee, Arizona, (Mr. D. W. Art, P. O. Box 741), wants to sell a group of claims, either for cash, at a prospect price, or on a working bond. If you want to get in, here is your chance. This is the way he describes his property:

Anaconda Copper—Eleven claims, located in Warren mining district, Cochise county, Arizona. The group is located on the west contact of iron-porphyry and lime on line, and about 2,000 feet west of Shattuck, and joins the Copper Queen on the trend of developed ores in the Queen and Shattuck properties. The Shattuck has developed extensive high-grade ore bodies on the 400-foot level. Three of the claims are patented, and on these are thirty-five-foot shafts showing iron-porphyry, quartzite, devonian and carboniferous lime. The formation is identical with that of the producing mines, and the real mineralized zone denotes that orebodies will be developed at no great depth. Orebodies do not show on the surface at Bisbee; it usually requires 400 to 800 feet in depth to develop orebodies in this district; the ores are usually found in deposits in the fault lines of the iron-porphyry contacts. Nature never fakes in Bisbee.

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Experiments have shown that unless there is an unusually large amount of dust in suspension in the air, ignition does not take place from a naked flame. Dust explosions are the result of violent compressions simultaneously with the production of a large, flaming area by the explosion of a charge.

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Steel tools may be hardened by using a solution of one gallon of common fish or whale oil and one pound each of beeswax and resin. Put into a kettle and heat till it comes to a boiling point, stirring it once in a while. When thoroughly mixed it is ready for use. Heat the steel till the scale rises a little, then immerse in the oil. When cool, heat over a clean fire till cherry red in the dark.

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Leaky valves may be repaired in the following simple manner: Remove the hood and sandpaper the brass valve disc bright where it sets on the seat, then go all around with a hot soldering iron and place a coating of solder all around it; when it is put back it will be found perfectly liquid tight. This scheme is not effectual where high-pressure steam is used, as it will not stand long in this case.

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Mildewing of canvas is prevented by applying the following composition: Sugar of lead, powdered, 3 pounds; water, 15 gallons; dissolve thoroughly and take of powdered alum 4 pounds; water, 15 gallons. Dissolve the alum and mix the two solutions thoroughly in a clean barrel or other suitable container and immerse the canvas, keeping it under the surface of the fluid for twelve to twenty-four hours. Then hang up to dry without wringing. The white powder (sulphate of lead) will shake off for a few days afterward.

THINGS WORTH KNOWING

Camp bread is easily made by the Lake Superior rule: One spoonful of baking powder for each cup of flour, with one spoonful of salt for the batch. Mix in water with the least possible stirring and bake quickly.

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The danger of explosion from gasoline is due to its vaporization and mixture with the right proportions of air. The liquid gasoline burns like kerosene or any other product of petroleum, and the flame only causes trouble under the special condition mentioned. Gasoline exposed to the air will vaporize and naturally diffuse in the atmosphere, and it is at such times that we are apt to hear of a funeral.

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The air-cushion automobile invented by Josef Hofmann, the pianist, and constructed at the Saurer Machine works, in the consular district of St. Gall, Switzerland, promises to bring about a revolution in automobile construction. In place of the usual steel springs, it has four brass cylinders for compressed air resting on the axles under the four corners of the automobile body, and these, by means of pistons and soft leather diaphragms, greatly reduce the swaying and jolting.

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To mark inscriptions on metals, take one-half ounce of nitric acid and one ounce of muriatic acid. Mix, shake the mixture, and it is ready for use. Cover the place you wish to mark with melted beeswax; when cold, write your inscription plainly in the wax clear to the metal with a sharp instrument; then apply the mixed acids with a feather, carefully filling each letter. Let it remain from one to ten minutes, according to the appearance desired; then throw on water, which stops the process, and remove the wax.

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For some 2,000 miles the Colorado river sweeps diagonally across the country from the high mountain plateau of Wyoming and Colorado to the farthest southwest corner of the United States. The basin drained by the Colorado and its tributaries is about 300,000 square miles in area. The control of the Colorado for the prevention of further outbreaks, such as its recent diversion into Salton sea, must involve thorough knowledge of the tributary flow, even in the high regions of its headwaters, in Colorado, and the ultimate steps taken to prevent disastrous inundations will, in all probability, involve the control of these upland tributaries. The size of the Colorado river is indicated by its discharge at Yuma in the year 1910. The heaviest discharge was in May, 70,300 cubic feet a second; the smallest discharge in October, 4,300 cubic feet a second. The total run-off for the year was 14,300,000 acre-feet, which would make a lake 1,000,000 acres in extent and 14.3 feet in depth.

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To make rubber packing air and steam tight, brush it over with a solution of powdered resin in ten times its weight of strong water of ammonia. This mixture when first made is unfit for use, but in three or four weeks it readily adheres to rubber as well as to wood or metal and becomes absolutely impervious to liquids. A good cement for joints in steam or water pipes, and which will set under water, is composed of 4 pounds paris white, ground; 10 pounds litharge, ground; ½ pound yellow ochre, fine; ½ ounce hemp, cut short. Mix well with linseed oil to a stiff putty.

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From time to time during the last six years the United States has made analyses of a large number of samples of coal collected by geologists from various states and fields. Most of the samples were taken in anticipation of the publication of a geologic report on the field from which they were obtained, but for various reasons the preparation of the several reports has been greatly delayed, and some of them have been postponed for consolidation with reports on other areas. In view of the fact that the analyses are valuable to persons interested in the fields from which the samples were taken, the Geological Survey has published the data for more than 160 of these samples in Bulletin 471-J.

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The "continental horsepower," which is used on the continent of Europe, differs from the English and American horsepower by more than 1 per cent, its usual equivalent in watts being 736. This difference is historically due to the confusion existing in weights and measures about 100 years ago. After the metric system had come into use in Europe, the various values of the horsepower in terms of local feet and pounds were reduced to metric units and were rounded off to 75 kilogram-meters per second, the English values being equivalent to 76.041. The bureau of standards of the United States has adopted 0.746 kilowatt as the exact equivalent of the English and American horsepower.

When the Stamp Mill Sounds Its Call

By AL. H. MARTIN

When the old stamp mill is roaring and the blasting shakes the hills,
And you hear the iron lyrics of the hammers and the drills,
When the clanging pumps commingle with the old compressor's song,
And you watch the mule-teams straining as they tote the ore along,
And you see your partners toiling as all honest partners should;
Then you ken Achievement's glory, and you know that God is good.

There's the call of fierce Endeavor in the thrilling mountain air,
Spurring on to deeds of boldness—calling all to do and dare,
Death lies grinning in the shadows where the mountain hoards its gold,
But the magic gold is calling, world-controlling, uncontrolled,
Calling fearless men to claim it—calling men of brawn and brain;
Not the puny souls of weaklings—and it hath not called in vain.

In this land of hearts of lions you're a man because you are,
Not because you father's father struck it rich on Fortune's Bar.
And the same mill sounds the sonnet of the mountains' laws and creeds.
Soulless words are naked nothings—men are measured by their deeds.
And the game is to the fearless and the nuggets to the bold,
For each man builds on his mettle 'mongst the seekers of the gold.

EACHING APPLIED TO COPPER ORE* (XXIII)

LPHATIZING OF CUPRIFEROUS MATERIAL BY ROASTING

By W. L. AUSTIN*

limont has published in "Metal-" (the February issues of 1909) an descriptive of roasting tests car-ut by him, which contains much of st from the view-point of copper metallurgists. The object of Warli- investigation was to discover a d of beneficiating nickeliferous otite which should be superior to now in use. It is well-known that ickel of commerce is at present produced by the "Orford," or the l" processes; but much secrecy has maintained regarding the costs of ng ore by these methods, and it is ed to be high because of extensive ulation.

kel in nature is usually associated copper and iron, so that treatment ore involves separation from both metals. The Orford process ac-ishes this result by repeated melt- of the associated sulphides with n sulphate and charcoal, whereby plex matte containing iron, copper lkali separates from, and floats on p of, a more or less pure nickel de. In the Mond process a current bonic oxide is passed over the iferous material, nickel is volatilized kel carbonyl, and this compound is lecomposed by heat. With both pro- the operation must be repeated a er of times to effect satisfactory ation of the metals.

the article referred to, Warlimont ses a wet method of treatment, in the sulphides are first given a tizing-roast, and then leached. upon tests made by himself, he es a process by means of which a iferous pyrrhotite can be treated so nearly all the copper is converted soluble sulphate, the iron into in-e ferric oxide, and the nickel for nost part remains in the original ide form. To bring about this result ows that the following is essential: roasting temperature must be main- between 450° and 480° C.; (2) this rature must be raised during the part of the operation to about 550° nd (3) the admission of air to the ng furnace must be under full con-so as to avoid over-heating the through too rapid combustion of lphides themselves.

ning Engineer and Metallurgist, side, California.

Warlimont's tests were carried out in a thoroughly scientific manner and he makes out a strong case in favor of his process. Of course, tests made on small batches of ore have always to be confirmed by a continuously operating plant before they attain commercial value. The sulphatizing-roast data furnished by Warlimont are not only applicable to the beneficiation of nickeliferous pyrrhotite, but are equally important in considering the metallurgical treatment of other copper-sulphide ore. Because of the many failures which have occurred, precisely in the roasting department, it is manifestly of interest to learn how chalcopyrite ore has been roasted so that ninety-odd per cent of the copper was leached out with acidulated water, and Warlimont's methods of accomplishing this will be discussed in the following. Any one especially interested in the separation of nickel from its combinations with sulphur, iron and copper, is referred to the original paper.

TEMPERATURES AT WHICH METALLIC SULPHATES DECOMPOSE.

In some preliminary experiments it was found that the temperature at which nickel sulphate decomposes is about the same as that at which copper sulphate breaks down, and that the first named salt is little, if any, more stable in the roasting-furnace than the latter, which fact is contrary to the statements of at least one prominent writer. At 600° C. nickel sulphate is said to be wholly unaltered, but at 650° the sulphates of both nickel and copper rapidly disintegrate.

With regard to the temperature at which copper sulphate decomposes, the following experiments, carried out upon a small scale, are recorded:

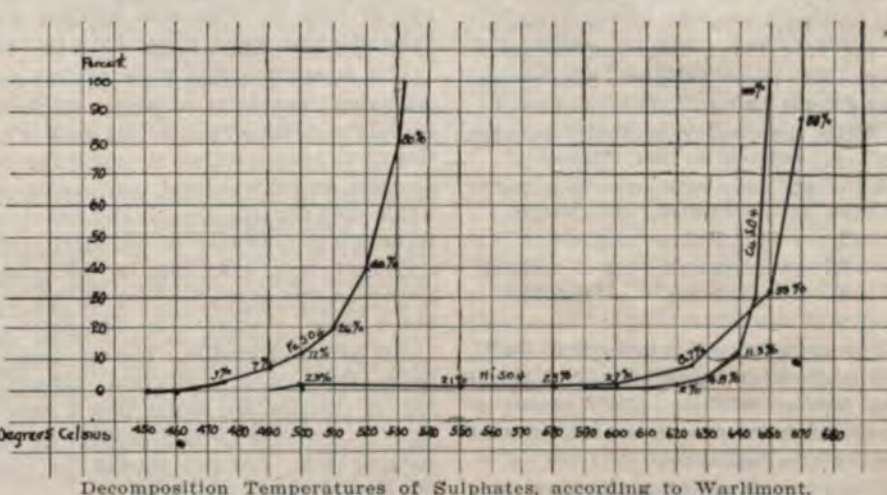
Some copper sulphate was dried at 250° C., and then analyzed 39.81 per cent copper and 59.87 per cent SO_4. When this material was heated at temperatures below 600° C. there was no decomposition, but at this temperature separation of the components of the salt gradually commenced, and increased rapidly at 650°. After roasting for three hours, the respective quantities of $CuSO_4$ decomposed at gradually ascending temperatures were:

Temperature.	Per Cent $CuSO_4$ Decomposed.
600° C	Traces.
610	"
620	2.0
630	4.8
640	11.3
650	100 0

With nickel sulphate decomposition set in somewhat earlier, and it appeared that the temperature at which this salt forms is not far from that at which it decomposes. The material used analyzed 64.1 per cent SO_4, and contained some free acid which may account for results obtained at temperatures below 600° C. Free sulphuric acid decomposes readily at 500° C.

After roasting for three hours, tests made with nickel sulphate showed:

Temperature.	Per Cent $NiSO_4$ Decomposed.
500° C.	2.3
550	2.1
580	2.3
600	2.7
625	8.7
650	33.0
670	88 0



Decomposition Temperatures of Sulphates, according to Warlimont.

For sake of comparison, the results obtained in treating ferrous sulphate in a similar manner are also included. When this salt is roasted in an air-current, following decompositions are thought to take place:

$6FeSO_4+3O=2Fe_2(SO_4)_3+Fe_2O_3$

$Fe_2(SO_4)_3=Fe_2O_3+3SO_3$

$SO_3=O+SO_2$

The roasting period was here also three hours, and the amount of ferrous sulphate decomposed at different temperatures is given as follows:

Temperature.	Per Cent $FeSO_4$ Decomposed.
450° C	Traces.
460	"
475	3
490	7
500	12
510	20
520	40
530	80
550	100

The temperatures at which the sulphates of copper and iron form, when their respective sulphides are given a sulphatizing-roast, are shown in the table below. The material used in these two roasting experiments contained respectively 76.2 per cent copper (Cu_2S) in the case of the copper test, and 63.5 per cent iron with 36.0 per cent sulphur, in the iron test. The temperature at which the iron sulphide was roasted ranged from 420° to 430°C.: that used in handling the copper sulphide, between 420° and 440° C.

Hours.	Per cent $FeSO_4$ formed.	Per cent $CuSO_4$ formed.
3	11.0	34.00
3.5	....	39.78
4	15.6	42.04
5	20.2	.....

It is seen from the table that $CuSO_4$ was produced more quickly and easily than ferrous sulphate. Only traces of nickel sulphate were found to form at temperatures below 600° C.

Measurements of furnace temperatures in all the tests were made with the help of an electric pyrometer connected with a milli-voltmeter.

IRON ASSISTS IN FORMATION OF SULPHATES.

Whereas it had previously been thought that the presence of iron interfered with the economical separation of nickel and copper, and therefore it was best to start with a concentrated matte, Warlimont showed by his experiments that iron exerts a beneficent influence when roasting for sulphates, in that it acts as a transferrer of oxygen, and with its help nearly all the copper can be leached out from a properly roasted pulp with acidulated water. At the same time the iron content of the lixivium can be so reduced by regulating the furnace temperature while roasting that it does not cause trouble in subsequent operations.

The following experiments indicate the influence of FeS on a sulphatizing roast. It is seen that varying quantities of FeS were roasted with identical amounts of Cu_2S, to ascertain the proportions producing best results. In the first experiment just sufficient FeS was present to furnish the sulphur necessary to bring all the copper into sulphate form.

$2Cu_2S+2FeS+19O=4CuSO_4+Fe_2O_3$

The roasting lasted three hours at about 450° C., and was afterwards raised to 530° to 550°. In this manner it was found possible to bring 83 per cent of the copper into sulphate form, with 3.1 per cent of the iron also as sulphate. There were only traces of sulphides left in the residue.

No. of experiment	Parts Cu_2S.	Parts FeS.	Pr. Ct. Cop. Sulphate form	Pr Ct. Ir. Sulphate form.
1	1	1	83.00	3.10
2	1	2	92.25	4.87
3	1	5	95.40	....
4	1	10	96.70	....
4 (repetition)	1	10	97.70	....

The leaching was done with water to which had been added sufficient hydrochloric acid to bring into solution any basic sulphate which might have formed.

The foregoing tests were carried out with small quantities of simple sulphides to obtain direct experimental data with regard to temperatures at which the respective sulphates form, and again at which they disintegrate. In the following tests larger amounts of material were employed, and constitute a laboratory demonstration of the working of the proposed new process for beneficiating nickeliferous pyrrhotite. The ore used in these tests was pulverized magnetic pyrites (pyrrhotite), so fine that it passed through a screen of fifty meshes to the running inch. Analysis showed the composition of these pyrites to be:

Sulphur	25.25	per cent
Iron	42 40	" "
Copper	0.75	" "
Nickel	3.10	" "
Silica	13.11	" "

The furnace employed was an ordinary muffle, gas heated, with a hole knocked in the back end so as to obtain good circulation of air.

The following experiments were made to ascertain the temperature best suited, and the length of time necessary, to bring the largest amount of copper into leachable form. In the first experiment the temperature was held for twelve hours at about 450° C. The resulting extraction of copper from the roasted pulp by water was:

After 4 hours 37.3 per cent copper.
" 10 " 60.0 " " "
" 12 " 73.3 " " "

In this experiment, as well as in those following, about two drops of sulphuric acid were added to each 300 cc. of the water used in leaching the roasted pulp.

The second experiment was conducted in the same manner, only the roasting temperature was maintained for four hours at 450° C., and then raised to 500°. The extraction was:

After 4 hours 40.0 per cent copper.
" 8 " 79.5 " " "
" 12 " 89.0 " " "

The temperature in the third experiment was held for four hours at 480° C., and after eight hours raised to 500°. The extraction was:

After 4 hours 39.0 per cent copper.
" 8 " 80.0 " " "
" 12 " 96.3 " " "

In the fourth experiment the roasting was carried on for 16 hours at 480° C., and the extraction was:

After 4 hours 45.0 per cent copper.
" 8 " 88.3 " " "
" 12 " 97.0 " " "
" 16 " 96.9 " " "

Of the nickel hardly more than ten per cent of that contained in the original ore was dissolved by the aqueous solution, and by raising the roasting temperature to 550° C., the iron content of the lixivium was reduced to a point where it gave no trouble in the following work. However, when the temperature was raised above 550°-600° C., the percentage of copper extracted slowly receded.

BEST ROASTING TEMPERATURES FOR SULPHATIZING COPPER.

It was apparent from these experiments that the best roasting temperatures for effecting sulphatization of the copper in the ore in question, was 480° C.; but it was also found that a large amount of iron went into solution. This was particularly the case in the first experiments, after the pulp had been roasted four and eight hours. When, however, the temperature was raised after formation of the copper sulphate was completed, then the greater part of the iron passed over into insoluble form without copper sulphate being decomposed.

The progressive formation of ferric oxide (Fe_2O_3) is disclosed by the changing color of the pulp. At first this was blackish-grey, which altered to a dirty red-brown after about six to eight hours. With continuous roasting for about 12 hours, or when the temperature is raised, the pulp takes on a beautiful red color, due to formation of insoluble ferric oxide, and the most of the iron is then found to be in the insoluble state.

To ascertain the relative amounts of copper, nickel, and iron going into a

form at varying temperatures and
g periods, a further series of tests
idertaken. In these the percent-
iron and nickel are given in terms
er.

riment No. 1.—The ore was roasted
hours at a temperature of 480°C.
pper extraction was 95.6 per cent.
civium contained 23 parts nickel,
iron, for every 100 parts copper.

riment No. 2.—Raising the tem-
e to 500° C., and roasting for 10
gave an extraction of 96 per cent
opper, and the relative amounts of
and iron in the lixivium were
ively 35 parts nickel and 230 parts
100 parts copper.

riment No. 3.—Eight hours roast-
480° C., followed by four hours at
Copper extraction 94.5 per cent.
e proportions of metals in the
n: 100 copper; 37 nickel; 103 iron.

riment No. 4.—Ten hours roasting
C.: four hours at 550°. Copper
ion 96.7 per cent. Metal content of
n: 100 copper; 53 nickel; 67 iron.
ion of this experiment gave 96.3
nt extraction. The livivium con-
100 copper; 45 nickel; 53 iron.

riment No. 5.—Nine hours roast-
480° C. Then temperature raised
ut 600° for three hours. Copper
ion 92 per cent. Lixivium: 100
; 63 nickel; 32 iron. This experi-
repeated gave: copper extraction
r cent. Lixivium: 100 copper; 51
45 iron.

data contained in the above ex-
nts, it appeared inadvisable to
e roasting temperature above 550°
ause at higher temperatures cop-
raction was shown to be less com-
nd more nickel went into soluble
As some of the iron in the roasted
emained as ferrous salt, two ex-
nts were then made to ascertain
ect of allowing this ferrous salt to
in the air, and of employing the
g ferric sulphate as lixiviant for
rtion of the copper content of the
hich had remained insoluble in an
s solution of the strength previous-
t.

arrying out this test two batches
were roasted, and then both were
oist, and stirred often during the
ys that they were exposed to the
hey were then lixiviated. In these
the following results were ob-

COPPER EXTRACTION.

Test—
fore air oxidation:
73 per cent copper.
Cu; 22 Ni; 430 Fe.
ter air oxidation:
87.5 per cent copper.
Cu; 19.5 Ni; 225 Fe.

Second Test—
Before air oxidation:
89 per cent copper.
100 Cu; 43 Ni; 289 Fe.
After air oxidation:
96.5 per cent copper.
100 Cu; 40 Ni; 87 Fe.

A third batch of pulp was roasted so that 94.7 per cent of the copper was extracted by acidified water, and then the pulp was treated as in the last two tests by exposing it to air in a moist condition and repeatedly stirring. The soluble copper content then rose to 95.3 per cent, and the relations of the metals in the lixivum were:

Before air exidation:
100 Cu; 32 Ni; 61 Fe.
After air oxidation:
100 Cu; 31 Ni; 46 Fe.

Other tests were made in which the roasted pulp was exposed to the air for longer periods; but the results given above were not materially changed.

The explanation offered for the fact that an additional amount of copper went into solution by exposing the moistened pulp to air, is, that in an insufficiently roasted material there are present a number of not fully oxidized copper combinations which are insoluble in acidified water, but are oxidized and dissolved by ferric sulphate resulting from oxidation of the ferrous salt. Among such compounds of copper which are insoluble in weak solutions of sulphuric acid are the sulphides of copper (Cu_2S and CuS) and cuprous oxide (Cu_2O).

SUMMING UP RESULTS OF FOREGOING EXPERIMENTS.

Summing up the results of the foregoing experiments it is seen that when roasting has been properly conducted 97 per cent of the copper content of a magnetic pyrite can be brought into the form of soluble sulphate, while barely ten per cent of the nickel is taken up by the solvent. To obtain these results there must be an adequate amount of iron sulphide present in the ore. Any ferrous or ferric sulphate that forms in the roasting is converted for the most part into oxide.

With regard to the proper style of furnace in which the sulphatizing results given in the foregoing might be obtained upon a commercial scale, Warlimont recommends a revolving drum, closed at both ends so as to prevent escape of dust. In such a furnace the temperature can be kept under strict control, which item has been shown to be essential to success. From a series of sulphur dioxide determinations made, (which are given in the original paper), it was determined that a plant equipped with two such furnaces would furnish gas of proper constituency for the manufacture of sulphuric acid.

Reference is also made to the leaching works at Predazzo in southern Tyrol, where a furnace of this description was in commercial operation. This furnace at Predazzo (described in "Metallurgie" 1909, page 581) put through between four and five metric tons of ore in 24 hours, the sulphatizing roast being carried to such a point that 96 per cent of the copper was in soluble form.

It is also recommended that comminution of the ore be not carried too far. It was found that a satisfactory roasting and lixivation was obtained when a screen was used with less than 25 meshes to the running inch. With material of this size from two to three per cent of the sulphur remained in the pulp after leaching, and this was almost entirely combined with nickel. When a coarser grained material was treated, the copper extraction fell off notably, and the sulphur content rose to seven per cent. In charging the leaching vats it is recommended that the lixiviant be introduced through the filter-bottom while the roasted material is being placed in the vat, so that it may become evenly moistened. When the vat is three-quarters full, and the lixiviant has risen to the top of the vessel, ingress of the liquor should be stopped, and direction of flow reversed. With roasted material of suitable size, it is stated that no difficulty was met when drawing the lixivium off through the filter-bottom.

Warlimont also furnishes figures relative to cost of plant designed for using his method, as well as cost per ton of ore treated. The proposed plant was designed for treating an ore in Norway, and the machinery was to be of German manufacture. It was proposed that the works should handle 22,000 tons (@2,000 lb.) yearly, and the cost of power is given at $7.50 (30 Marks) per horsepower-year. In the following estimate the Mark is taken as the equivalent of 25 cents, and those items which refer only to the nickel end of the business are omitted.

COST OF PLANT.

Crushing machinery	$ 16,500
Roasting department	15,000
Refractory building material	4,250
Leaching department	4,125
Sheds	1,875
Cementation	5,000
Laboratory	2,500
Wooden buildings (one-half)	6,250
	$55,500

COST OF TREATMENT.

	Per Ton.
Crushing	$ 0.750
Roasting	0.625
Transportation	0.050
Leaching	0.100
Drying	0.0375
Cementation (inclusive iron)	0.2500

Wages @ $0.875 per diem (one-diem)	0.6375
Salaries and laboratory	0.3000
Repairs and renewals	0.0750
	$2.8250

As the crushing was only carried to 25 mesh, this item of expense ($0.75 per ton) seems unduly high. The wages are low, but the number of employes (150) is very great. Power is, of course, extremely low. A point of special interest in this estimate is the specific cost of leaching, which is figured at $0.10 per ton of nickeliferous pyrrhotite.

If an ore carrying 2.5 per cent copper were treated by this method, with ninety per cent extraction, according to Warlimont's estimates, the cost per pound copper would be $0.064. This, however, does not include costs of mining, interest on investment, nor amortization, and leaves the copper in form of precipitate. In most cases electrolytic copper could be produced for the same figure or less.

Conditions Affecting The Value Of Gold

By JAS. O. CLIFFORD*

The attempt to answer this question in a satisfactory manner has engaged the attention of economists more than any other problem in pure theory, and, while much has been accomplished theoretically, many knotty problems have been presented which, in practice, precludes a clear understanding of the subject. However, in briefly outlining the subject, it is the intention of the writer to present only those points which have been exhaustively discussed by the world's greatest political economists, and which points have a direct bearing upon the question in hand. The works of Mill, Walker, Jevons, Cairnes, Nicholson, and others, have been consulted, and due credit is given each author where excerpts from the original treatises have been used. It should be understood by the reader that no attempt to treat the subject in its entirety is at all contemplated by the writer, and where further information is required on any particular question I need only refer him to the standard works on the subject of political economy.

Before considering the causes determining the value of gold, it will first be necessary to briefly review the general laws of value, and, therefrom it will easier to understand the subject.

Production is the most fundamental of the laws of value, the requisites therefor being three, viz., (1) labor, (2) appropriate natural objects, and (3) capital. The product resulting from the action of those three forces is then considered as having an inherent value, which term implies at least two meanings—value in use, and value in exchange. However, the conception of utility is the most fundamental in economics, and while value in use is obviously much wider in its application than value in exchange, it should always be understood that by value in political economy is meant value in exchange. In this connection, however, exchange value requires to be distinguished from Price. Writers employed Price to express the value of a thing in relation to money—the quantity of money for which it will exchange. By the price of a thing, therefore, is understood its value in money; by the exchange value of a thing, its general power of purchasing, or, more clearly, the command which its possession gives over purchasable commodities in general. Therefore, one who talks of the exchange value of anything means the number of dollars, pounds sterling, and soforth, which it will bring in the market. On this view then the value of a thing is its price. There is such a thing as a general rise of prices, (all commodities may rise in their money price) but there cannot be a general rise of values. If one-half of the commodities in the market rise in exchange value, the very term implies a fall of the other half; and, conversely, the fall implies a rise. This line of argument leads to the position: "The idea of general exchange value originates in the fact that there really are causes which tend to alter the value of a thing in exchange for things in general; that is, for all things that are not themselves acted upon by causes of similar tendency." Following out this idea Mill proceeds to say that any change in the value of one thing compared with things in general may be due either to causes affecting the one thing or the large group of all the other things, and that, in order to investigate the former, it is convenient to assume that all commodities but the one in question remain invariable in their relative values. On this assumption any one of them may be taken as representing all the rest, and thus the money value of the thing will represent its general purchasing power. That is to say, if for the saks of simplicity we assume that the prices of all other things remain constant, but that one thing falls or rises in price, the fall or rise in price in this thing will indicate the extent of the change in its value compared with things in general.

REQUISITES FOR VALUE.

The theory of value is essentially an examination of the causes which determine the value of particular commodities relatively to a standard which is assumed to be fixed. Therefore, in order that anything may possess value in this sense, that it may exchange for any portion of standard money, or its representatives, it is evident that two conditions must be satisfied. First, the thing must have some utility; second, there must be some difficulty in its attainment; the difficulty of attainment, however, sometimes consists in an absolute limitation of the supply. In this connection it is interesting to note that there are some articles of which the supply may be indefinitely increased, but cannot be rapidly diminished. There are things so durable that the quantity in existence is at all times very great in comparison with the annual production, among which are platinum, gold, silver, and other durable metals. The supply of such things might be at once diminished by destroying them; but to do this could only be to the interest of the possessor if he had a monopoly of the article, in which event he could repay himself for the destruction of a part thereof by the increased value of the remainder. The value, therefore, of such things may continue for a long time so low, either from excess of supply, or falling off in demand, as to put a complete stop to further production; the dimunition of supply by wearing out being so slow that a long time is requisite, even under total suspension of production, to restore the original value.

LAW OF SUPPLY AND DEMAND.

Demand is defined as the quantity of any article demanded at some particular price, in which instance the one demanding the price can readily meet his engagements; in other words, there must be what is termed an effectual demand.(1) Further, by demand it must not be assumed simply as a desire to possess, because in a sense everyone desires everything and the less the mean of payment, so much greater in general is the desire. Also, it is absolutely necessary to insert the qualifying clause "at some particular price," because, as a general rule, with

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Notations:
(1) Mill, J. S., Political Economy.
(2) Jevon, C., Political Economy.
(3) Walker, F. A., Money.
(4) Nicholson, J. S., Political Economy.

a change in price a different quantity will be demanded. In fact, the variation of quantity demanded, according to variation in price, is that which gives rise to the statement of the general law of demand which is: That as the price of any article falls, other things remaining the same, the quantity demanded increases, and, conversely, as the price rises, the quantity demanded decreases.

Supply in a similar way may be defined as the quantity offered for sale at some particular price. As the price rises, other things remaining the same, the quantity offered tends to increase, and conversely, as the price falls, the quantity offered tends to diminish. From which it follows that, as a general rule, things tend to exchange for one another at such values as will enable each producer to be repaid the cost of production with the ordinary profit. It is, therefore, apparent that the latent influence by which the value of things are made to conform in the end to the cost of production is the variation that would otherwise take place in the supply of the commodity; that is, the supply would be increased if the thing continued to sell above the ratio of its cost of production, and would be diminished if it fell below that ratio. This considers that the value of a thing is proportional to its cost of production, and by this is meant the point to which it always tends to return, the center value toward which the market value of a thing is constantly gravitating; and any deviation from which is but a temporary irregularity which, the moment it exists, set forces in motion tending to correct it.

COST OF PRODUCTION.

The component elements of cost of production are labor and capital acting by natural forces upon raw material; but, since both the forces and the produce of nature require labor and capital for their exploitation, the elements that must be considered fundamental in the case of commodities that can be indefinitely increased are labor and capital. Capital is itself a product of labor. It is apparent, therefore, that, in order that a thing may be continuously produced, labor must obtain a sufficient reward for its toil, and capital a sufficient reward for preservation and the accumulation of wealth. It is a necessary condition of the production of any article that the price obtained will yield the necessary wages, and a fair profit for that species of work. These rates of wages and profit can be, as generally they are, stated in terms of money, and it is at this point that the difficulty emerges as to the precise nature of the connection between the prices of commodities and the money wages and profits of producers. It follows that, if all commodities were produced directly by the expenditure of labor, and in such a way that capital need not be considered, then the only element to consider in value would be the quantity of labor. And, in a more highly developed state of society in which wages were paid, if we consider that the rate of wages is uniform, and that the profits may be disregarded in comparison with wages, the quantity of labor is the most important consideration, and a decrease in the relative value of any article can only take place through some economy in labor.

However, as we approach the actual constitution of modern industrial societies we observe more serious differences in the rates of wages in different employments, the use of fixed capital becomes of greater importance, and in some cases the lapse of time necessary for the completion of the commodity is considerable. Thus interest and profits, as well as the differential rates of wages have to be taken into account just as much as the quantity of labor, and it is generally convenient to consider also the established differences in various returns to capital under different conditions. Indirectly, of course, since all capital in the ordinary sense is the result of labor, the quantity of labor is always of primary importance, but, in considering the cause of relative values, it is always best to consider capital and labor as independent factors.

When comparing the relative values of two commodities, however, we should take into account the relative wages and relative profits, and the relative amounts of capital and labor employed in their production. Obviously any change in the relative wages and profits will affect the relative values, and, if the proportions are different in which labor and capital are employed in the production of any two commodities, then any change in the general rates of wages and profits will affect relative values. Hence two important practical conclusions of a general character have been drawn: (1) Relative values are liable to constant disturbances, and accordingly, since relative prices tend to be adjusted to relative values, relative prices must be constantly changing. (2) It is extremely difficult to measure changes in the value of the monetary standard, or movements in the general level of prices, or variations in the purchasing power of money.

VALUE OF MINING PRODUCE.

The value of mining produce is determined generally in the same manner as that of other commodities, but similar qualifications must be introduced. The theory is that both extensively and intensively the produce of mines is subject to the law of diminishing return, that the margin recedes as the price falls and extends as it rises, and that thus the price is determined by the most costly portion which it just pays to market. In general the produce of mines is, like that from many other sources, consumed in a comparatively short time, and thus the value is subject to fluctuations according to the conditions of the annual demand and supply. The peculiar durability of the precious metals, however, makes them in this respect differ widely from most mining produce. Therefore, it is of course undeniable that, supposing coinage free, the value of standard coins will be equal to the value of the same amount of bullion, and, conversely, that the bullion will be equal in value to the same amount of coins.

The older economists argued that the precious metals had their value determined by their cost of production under the most unfavorable circumstances, and then argued that in consequence the value of money tended to be governed by the cost of production of bullion. If, however, it is remembered that the annual production does not probably amount to but a fractional part of the quantity in the hands of man, that cost of production can only operate through actual or potential supply, and that in the case of money the increase must be real to affect prices, it will readily be seen that the value of bullion is determined by the general level of prices (or the value of money), and not that the value of money depends upon the value of bullion. At the same time, however, it is true that, if prices become very high (in other words, if the value of money, and thus of bullion, becomes very low), then a check is placed upon production from the mines, and, conversely, with falling prices, or a rise in the value of the precious metals, mining for them is extended and encouraged. On the whole, this case of the precious metals furnishes perhaps the best example of the way in which the cost of production can only act through the law of supply and demand.

From the foregoing it is quite apparent that, in order that the value of gold be more clearly understood, we must consider the relation, in brief, between the actual production of precious metals as bullion, and the causes which have led to the adoption of a monetary system and the operation of the latter.

MONEY.

The clearest definition of money is that given by Walker as being 'That which passes freely from hand to hand throughout the community in final discharge of debts and full payment for commodities, being accepted equally (without reference to the character or the credit of the person who offers it, and without the intention of the person who receives it

to consume it or to enjoy it or apply it to any other use than in turn to tender it to others in discharge of debts or payments for commodities."(3). Therefore, the most important function of money is that of affording a ready means of estimating the comparative value of different commodities, and, it is apparent that, without some common commodity as a standard of comparison, this would be impossible. Hence, according to Jevons, "The chosen commodity becomes a common denominator, or common measure of value, in terms of which we estimate the value of all other goods."(2)

Another equally important function of money comes into being with the increase in relations of contract. As a contract implies something to be done in the future there must be some means of estimating the value of that future act, therefore, a standard is required; and here money, which already acts as a medium of exchange, and as a measure of value at a given time, performs a third function by affording an approximate means of estimating the present value of the future act, and in this respect may be regarded as a standard of value of deferred payments. Summarized, the function of money are: (1) the common medium by which exchanges are rendered possible, (2) the common measure by which the comparative values of those exchanges are estimated, and (3), the standard by which future obligations are determined.(4) The causes which determine the value of money is a particular case of the general problem of values. As remarked in a previous paragraph, "the value of a thing is what it will exchange for; the value of money, therefore, is what money will exchange for, or its purchasing power. If prices are low, money will buy much of other things, and is of high value; if prices are high, it will buy but little of other things, and is low of value.—Mill."

In considering the terms supply and demand as applied to money it is interesting to note that, while the supply of any commodity means the quantity of it which is offered for sale, and the demand for a commodity is the purchasing power offered for it, supply in the case of money means all the money in circulation at a particular time, and demand in the special case of money consists of all the goods offered for sale. From the peculiar feature in the case of money, which arises from its position as the medium of exchange (that is, that it is in a constant state of supply and demand) it follows that the factors which determine the value of money within a given time are: (1) the amount of money in circulation, and (2) the amount of goods to be sold. Furthermore, in determining the value of money the varying rates of circulation (efficiency of money—Mill) have to be considered, and on the side of demand, it is not the quantity of commodities that is the determining element, but the amount of sales. In this connection it also should be observed that, in addition to commodities, services of all kinds, payments of interest on various forms of obligations, and the influence of credit must also be considered as exerting a tremendous influence on the value of money. Further, the value of money as stated by Mill, is inversely as its quantity multiplied by what is called the rapidity of circulation. The essential point is, not how often the same money changes hands in a given time, but how often it changes hands in order to perform a given amount of traffic. The comparison should be made by the number of purchases made by the money in a given time, not with the time itself, but with the goods sold in that same time.

It is plainly evident, however, that the mere introduction of a particular mode of exchanging things for one another, by first exchanging a thing for money, and then exchanging the money for something else, makes no difference in the essential character of the transactions, for the reason that it is not with money that things are really purchased. Nobody's income, except that of the precious metal miner, is derived from the precious metals constituting money. The money which a person receives is not what constitutes his income; it is merely an order which he can present for payment at any shop he pleases, and which entitles him to receive a certain value of any commodity that he desires. There is no clearer explanation of this feature outlined than that given by Mill in which he states that payments are made in money as the most convenient plan for those concerned, and, when a master pays his servants in money he is merely giving them their share of his property for services rendered, and it makes no essential difference whether he distributes their real income in shares of his property, or whether he sells it for them and gives them the price. In fact, there is not, intrinsically, a more insignificant thing than money, except in the character of a contrivance for sparing time and labor.

The introduction of money does not interfere with the operation of any of the laws of value. The reasons which make the temporary or market value of things depend on the demand and supply, and their average and permanent values upon their cost of production, are as applicable to a money system as to any other system. The relations of commodities to one another remain unaltered by money. Money is a commodity, and its value is determined like that of other commodities, temporarily by demand and supply, and on the average, by cost of production. The value of money, then, conforms permanently to the value of the metal of which it is made; with the addition, or not, of the expenses of coinage, according as those expenses are borne by the individual or by the state.

THEORY OF INTERNATIONAL VALUES.

The discussion which has repeatedly taken place on the question as to whether a distinct theory of international values is required is best explained by making clear the assumptions on which the values of commodities produced within a nation are determined, and then considering the changes which must be made when we bring in other nations. Briefly, a nation in the sense of the present use of the word might perhaps be more advantageously described as a place wherein there is effective industrial and commercial competition—more satisfactorily termed an economic area. The application of effective industrial and commercial competition to international trade is equally as apparent as though but one economic area were considered, for, so soon as trade is established the commodities will sell for the same price in all other countries into which it is imported—due allowances being made for cost of carriage, and other incidental charges. If there is any real difference between domestic and international values, it must arise owing to the absence of effective industrial competition; that is to say, in the same economic area the real cost determines the expenses of production.

It thus follows that a country may import articles which it could produce at less real cost, provided that it pays for these imports with exports that cost even less. According to this theory every country will devote its labor and capital to its most productive uses. It must, therefore, be assumed that in the absence of loans, tributes, and so forth, imports can in the long run only be paid for by exports, and also that those articles will be exported which can be produced at the least comparative cost. This theory then may be held to explain in a satisfactory manner the origin and development of international trade, but the question of values is still undetermined. Consistently with exports paying for imports many different rates of exchange are possible, and the particular rate actually adopted depends entirely upon reciprocal demand. And in extreme cases, in which new countries trade solely in articles of which each has a monopoly, this answer would seem to be correct; but, when we consider that under present conditions trading countries have many articles in common, and that a slight margin of profit

es to expand or diminish an export , this eplanation seems too vague. e most probable solution, therefore, s to be that the rates of exchange be so adjusted as to give to the ex-rs the ordinary rate of profit cur-in their respective countries. In al it is clear that the rate will be ined independently of the foreign or at least that the foreign trade is factor to be considered. However, ollowing, known as the Equation of national Demand, fully explains the tion. "The produce of a country ex-ges for the produce of other coun-at such values as are required in that the whole of her exports may pay for the whole of her im-."(,) This law of International s is but an extension of the more al law of value.

VALUE OF GOLD.

e quali:ies necessary to fit any com-ty for being used as money are pos-d in nearly an equal degree by the ls, gold and silver. Some nations, therefore, attempted to compose circulating medium of these two ls indiscriminately. There is an ob-convenience in making use of the costly metal for larger payments, the cheaper one for smaller. The most frequently adopted has been tablish by law a fixed proportion be-n the two metals, it being left to yone having payments to make to in either the one metal or the other. is connection if natural cost values ys continued to bear the same ratio ch other, the arrangement would be jectionable. Gold and silver, though least variable in value of all com-ities, are not invariable, and do not ys vary simultaneously. In view of ral economic conditions in the min-and metallurgical industries, either or silver is at any time subject to nt fluctuations, in which event the of the two metals relatively to each r would not agree with their rated ortion.

ppose, for example, that gold rises lue relatively to silver, so that the tity of gold in an American dollar is h more than the quantity of silver in ty (20) silver dollars. The result d be that all payments possible would ade in silver coin for the special rea-hat it would not be to the interest of ebtor to pay in gold. The converse of would happen if silver, instead of were the metal which had risen in arative value. The money of a com-ity, therefore, would never really con-of both metals, but of the one only h, at the particular time, best suited interest of the debtors; and the dard of currency would be constantly e to change from one metal to the other, at a loss on each change, of the expense of coinage on the metal which fell out of use. This is the operation by which is carried into effect the law of Sir Thomas Greshman to the purport that "money of less value drives out money of more value."

It appears, therefore, that the value of money is liable to more frequent fluctuations when both metals are a legal tender at a fixed valuation than when the exclusive standard of the currency is either gold or silver. The modern practice, however, considers the adoption of gold, the more costly metal, as a standard, and silver, while retained in circulation as a legal tender for small payments, is rated in comparison with gold, so that a turn of the market in its favor will not make it profitable to melt the silver coin. Further, overvaluation of the silver coin creates an inducement to buy silver and send it to the mint to be coined, thereby, receiving back a higher value than properly belongs to it; however, this has been guarded against by limiting the quantity of silver coinage, and by the enforcement of stringent regulations governing the relative ratios of silver to gold, which, while they have been changed from time to time in the United States, as well as in other gold standard countries, cannot, under any circumstances, be maintained contrary to the operation of the law of supply and demand.

We can readily assume an assigned constant price of $20.67 per Troy ounce of pure gold merely as a basis of the relative value of that commodity as compared to other commodities in general, or vice versa, but by no means does that price represent the actual value of the gold. In fact any arbitrary price which we might deem advisable to assign to gold would operate merely as a matter of convenience to ourselves and would, insofar as the actual value of metal is concerned represent nothing at all. Contrary to the general belief gold is subject to the same variations in value (although in a lesser degree) as all other commodities, but its variations while real are not so apparent as in the case of other commodities in view of the fact that we are in the habit of always making our comparisons on the basis of "value" of gold remaining at $20.67 per ounce, and all other commodities rising or falling in price relative thereto. Nothing could be more misleading and, generally, we should learn to consider every appreciation in the price of other commodities, as compared to gold, to indicate a corresponding depreciation of gold compared to those commodities. In fact, it is only along this line of reasoning that we can learn to fully appreciate the economic influence of the standard of currency. It should be remembered that gold, either as bullion, or as a coin having a designated "value" in the different countries, is no more than a commodity—just as sugar, rice, or any other like thing is a commodity—and that its exchange value is subject to similar variations,—dependent upon the law of supply and demand.

CONCLUSION.

While the subject could have been more extensively treated it is hoped by the writer than the brief outline above given will suffice to at least afford an insight into the general laws governing the value, not of gold only, but consistently of every other material thing with which mankind has to deal. The immutable law of compensation corrects everything of which the human mind can conceive. Just as the sea, it everywhere tends to a level; its surface is always ruffled by waves, and agitated by storms, but it is enough to point out that at least, no point in the open sea, is permanently higher than another. Each place is alternately elevated and depressed, but the ocean preserves its level.

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From a report made by an "engineer," the following sentences are culled, says the Mining and Scientific Press: "The vein occupies a fissure of large extent horizontally and perpendicularly along the axes of an incline, with a strike north and south standing perpendicularly." * * * "Working of this mine consists of approixmately 8000 feet and a shaft 600 feet deep, originally operated as a tunnel to a depth of about 400 feet." Interesting food for reflection may be found in determining whether an incline "standing perpendicularly" is a greater natural wonder than a tunnel which has been plunged into the earth to serve as a shaft.

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During August, the mints of the United States coined 25,101,000 pieces valued at $1,317,000, as follows: gold, 101,000 pieces worth $505,000; silver, 2,-400,000 pieces worth $586,000; and copper (one cent) 22,600,000 pieces worth $226,000.

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In testing oxidized gold ores, pulverize the sample in place in a porcelain lined vessel or tea cup, cover with iodine and allow it to stand from two to three hours. Then dip into it a piece of white filter paper, dry and burn it, and if it gives a purple color gold is present, and the deeper the purple the richer the ore. For other ores with this test, such as pyrites, the ore must be roasted. Where lime is present the ore must be roasted twice, the second time adding carbonate of ammonia. After roasting, test as with oxidized ores.

From Copper To "Gold Mines"

This space is reserved for the picture of A. F. Holden, the other eminent engineer who lent his name and gave his endorsement to the electrifying report on Alaska properties submitted herewith and which will be reproduced from month to month.

NOTED ENGINEERS JOIN BROKERAGE HOUSE IN A REMARKABLY PECULIAR PRESENTATION OF AN ALASKA GOLD MIRAGE.

We have received a few inquiries from readers who wished to know why we did not publish all of the "report" of Messrs. Jackling and Holden of the Alaska Gold Mines Company instead of the following "extracts." In reply we wish to explain that, if there ever was anything more than these "extracts" made public we have ben unable to trace it. When Hayden, Stone & Co. sent out the letter inviting subscriptions to the stock they did it on the STRENGTH of the contents of these "extracts." Or that is the presumption, at least. That intending purchasers and investors at once became suspicious and have since kept hands off is indicated by the wording of nearly every line of publicity that has since been given the proposition. But read the "report" again. Here it is:

Extract From Report of Messrs. Jackling and Holden.

We have considered the PROBABLE capital requirements for a capacity of 6,000 tons per day, which contemplates a hydro-electric power plant; mine development and equipment, including all the necessary living quarters, both at the Perseverance mine proper and at the mill, and driving the long adit tunnel. We BELIEVE that $4,500,000 will do this work.

Our BELIEF is that the substantially INDICATED ore body is about 4,500 feet long by by seventy feet wide. The value of the 600,000 tons of ore THAT HAVE BEEN MINED FROM THIS BODY IN THREE DIFFERENT LARGE STOPES INDICATES that a recovery of at least $1.50 per ton can be made. We BELIEVE that there will be 75 cents per ton profit in this grade of ore. The Sheep Creek Tunnel, which will be driven on the vein as the main haulage level, will develop this ore body at an average depth of about 2,200 feet on the dip of the vein, or about 700 feet deeper than present developments.

The character of this vein is similar in A VERY GENERAL WAY to other large deposits of gold ore in the same vicinity in which the values at a vertical depth of 1,600 feet, or 2,000 feet on the dip of the vein from its apex, are practically the same today as they were on the surface, and have been throughout the development of THE DEPOSITS IN QUESTION. We visited these mines and saw THEIR deep levels, and, if there is any inference to be drawn from the continuity of THESE ore bodies, WHICH ARE NOT, HOWEVER, ON THE SAME VEIN AS THE PERSEVERANCE, one MIGHT BE TEMPTED to say that there is a PROBABILITY of ore 2,500 feet deeper than the so-called Sheep Creek Tunnel which we contemplate driving, BUT, while the PROBABILITY is there of the vein and values extending to great depth, THERE IS NOTHING TODAY TO WARRANT ANYBODY IN STATING THAT IT IS A FACT THAT SUCH WILL BE THE CASE.

There are substantially 50,000,000 tons in the ore body we consider definitely INDICATED. There is a PROBABILITY of another 2,000 feet to the east of the 4,500-foot ore zone previously mentioned, which, from surface indications, would seem FAIRLY CERTAIN to contain ore. Beyond this is some 1,800 feet of the vein concerning which we have NO FINAL OPINION one way or the other, AS WE VISITED NO WORKINGS OR OUTCROPS from which we could secure sufficient data to form accurate deductions. While we cannot at this time state that there 'S ore here, there were several SMALL MINES worked almost at the extreme east end of the vein on this property, which INDICATES that this 1,800 feet will undoubtedly produce considerable ore and PERHAPS LARGE QUANTITIES. If we do not consider this in the PROBABILITIES, it is certainly well within the POSSIBILITIES.

This letter is based solely on a consideration of $1.50 recoverable value as ore. If one should figure on lower values, assuming 75 cents as the total cost of mining and milling, the tonnage now indicated is INDEFINITE, but certainly enormous. We BELIEVE that sound mining business will INDICATE that for the installation now proposed and for an operating period of, say, two years, IT WILL BE WISE TO CONFINE OUR WORK TO THE HIGHER GRADE ORE. There can be, in our opinion, little doubt that at some time in the comparatively near future A VERY MUCH LARGER PLANT than the one now proposed will be installed for the purpose of working a larger tonnage of the normal grade ore we now EXPECT will be developed, or of utilizing the apparently vast quantity of lower grade material.

The INDICATED earnings from the installation now contemplated are approximately $1,500,000 per annum. Considering the TREMENDOUS POSSIILITIES, and we use the word "tremendous" advisedly, we BELIEVE this mine to be a LEGITIMATE purchase at $15,000,000 and A BARGAIN at $12,000,000, provided that, in both cases, a development, equipment and working fund of $4,500,000 is made available. You must understand and appreciate that we do not consider the 6,000-ton per day development and installation as the ultimate possibility of the mine or anywhere near it. The POSSIBLE tonnages of ore INDICATED in this property APPEAR to be greater than any vein deposit WE know about.

We EXPECT the first unit of the new mill to be in operation on or before January 1st, 1915. We really BELIEVE that, barring accidents, the time MAY be made July 1st, 1914.

(Signed, D. C. JACKLING.
July, 1912. A. F. HOLDEN.

XPLOITING THE DEEPEST AMERICAN GOLD DEPOSITS

By AL. H. MARTIN.

r sixty years the Mother Lode has history. From the first strike of quartz on the Spring Hill claim in to the present date the region has one of the most consistent gold ers the world has ever known. The er Lode embraces five counties, dor, Calaveras, El Dorado, Tuolumne Mariposa, comprising an area of square miles. The lode strikes from geport, Mariposa county, northwest- to near the further boundary of El do, an approximate distance of 120 s. The region is geographically ted in the westerly foothills of the a Nevada mountains, in the north- ral portion of California. The forma- is composed largely of slate, sand- e and chlorite schist, with extensive s of granite and diabase. Broad belts orite, diorite schist, black slate and entine also occur. The serpentine is particularly prominent in umne and Mariposa. Main ore depos- occur in a clay-slate formation, at s altering to greenstone-schist. The entine contains numerous veins, but e though larger than other deposits rally lack high quality. Consider- faulting and shearing appears in slate and schist, with the parallel earing fissures numerous and vary- largely in extent. Pyrites abound, e galena, blende and other sulphides associated with most deposits. With ption of varying percentages of sul- ets, practically all the quartz is free ing. In such a vast mineralized ter- y the character and size of veins rally vary. In some districts the odies average from ten to forty feet, le in other sections the orebodies w widths of eighty to 150 feet. Nar- shoots of high-grade ore are frequent- encountered, and rich pockets have n found in most districts. On an rage values range from $5 to $8 per but numerous shoots containing $20 50 have been developed in many of big low-grade properties. Geographi- y the district is old, and it is believed usands of feet of the veins have been led during the centuries by the nat- force of the elements. Lindgren mates the deposits were originally ned at not less than 6,000 feet be- the surface, but the erosion of the s gradually wore down the protecting earth and carried off vast quantities of the veins.

Aside from its impressive extent, the Mother Lode is remarkable for the depth to which the deposits of commercial quartz extends, and the general free-milling character of the ore. From the earliest inception of mining on the belt the milling problem has been a simple one. Values have always been easily extracted by simple stamp crushing and amalgamation, and the more refractory ore has given up its gold to simple canvas concentrators and vanners. This naturally favorable condition led to the development of wonderfully profitable mines when the metallurgical science was in its infancy and influenced a tremendous influence on the development of western mining when refractory deposits would have checked the ardor of the most enterprising.

The depth to which commercial values prevail forms another striking feature of the lode. Particularly is this true of the Amador section of the belt, where much of the best ore has been extracted from below the 1500-foot levels. In their lower regions the mines are generally dry, and the absence of water and large dimensions of veins have facilitated the continuation of profitable operations at great depth. Some of the best producers at present were in former years considered practically valueless, and many of the most promising mines of today were reopened after long years of idleness.

ANNUAL PRODUCTION.

The annual output of the Mother Lode approximates 1,500,000 short tons, valued at about $5,555,000. Of this amount more than one-half the values and one-third the tonnage comes from Amador county. Calaveras and Tuolumne contributes most of the balance, the two counties of El Dorado and Mariposa playing minor parts. The figures of the U. S. Geological Survey credits Amador county with producing 692,806 tons of ore in 1911, yielding $2,832,395, compared with 547,875 tons in 1910, valued at $2,584,809. Calaveras yielded $1,112,315 in gold for 1911 and Tuolumne $1,093,484. The prominent part played by the Mother Lode in California gold production is evidenced by the fact that it contributes over 40 per cent of the states' quartz gold product per annum, and over one-third of the total gold yield from all sources. The lode has not played this part for a few brief years only, but virtually ever since the gold industry of California was placed on its present firm basis. Many of the mines commenced producing in the early '50s and still contribute large sums to the annual yield of the state. The average recovery from Mother Lode ores approximates $3.78 per ton. This ranges from the $2.25 ore of Calaveras to the small amount averaging over $7.40 from Mariposa properties.

DEEPEST GOLD MINES.

Paramount interest naturally centers on the Amador portion of the belt where the deepest gold mines in America are operated. First and foremost stands the Kennedy, the largest producer in California. This property has been developed to a vertical depth of 3,550 feet by a three-compartment shaft, and arrangements have been recently made to sink several hundred feet deeper. In the lowest workings the vein shows about fifteen feet of milling ore and it is expected to eventually intersect the footwall ledge at a depth of 4,400 vertical feet. This is the principal orebody and occurs in schistose greenstone. It has been the general condition that the veins have gathered strength with increased depth, while values have been well sustained. The shoots range from six to eleven feet wide, with lengths varying from 500 to 700 feet. The quartz occurs in slate with sulphurets and considerable free gold showing. Much of the ore runs into the ribbon rock type, with coarse gold and sulphurets deposited in the dark slate seams. Values average $5 to $10 per ton, including the occasional shoots of high grade found from time to time. The Kennedy first commenced production in the early '60s, and was several times condemned as a failure before enterprising and resourceful management placed it on its present basis. The development of the property marked the first comprehensive attempt to explore the Mother Lode deposits at great depth and the results largely influenced the determination of other operators to mine deep. The Kennedy produces about 180,000 tons of ore per annum, valued at approximately $1,000,000. The quartz if crushed in Knight rock-breakers and sent to the 100-

stamp mill. Silver-plated copper amalgam plates receive the stamp product, and the pulp continues to 40 six-foot Frue vanners and a complete system of canvas tables for further treatment. Concentrates are treated by the chlorination process, the Kennedy company operating a highly efficient chlorination plant. A complete description of this mine and plant appeared in the August, 1911, issue of Mines and Methods.

After the Kennedy, the most interesting of Mother Lode properties, is probably the South Eureka, near Sutter Creek. Like the Kennedy this property was condemned in its early infancy, and again after several years of vigorous development had failed to produce anticipated results. Its history is a striking testimonial to the faith of the Western miner and the dogged determination to compel Fortune to smile despite her darkest frowns. Unlike many other noted mines, the South Eureka gave no indication of the riches concealed within its ample bosom. For nearly thirty years the site of the mine was a mere agricultural tract, yielding bountiful harvests of grain. Neither outcrops or promise of ore existed; the land was flat, unbroken and seemingly devoid of mineral promise. For years the Oneida and Central Eureka had been worked, and the fact that the tract now comprising the South Eureka mine was situated between the two propties, led to the belief that veins continued under the prosaic farm lands.

Approximately twenty years ago James F. Parks decided the land invited investigation and forming a company of friends started explorations. Parks had transformed the Kennedy from an abandoned failure into one of the world's great mines, and hopes of the adventurers soared high. The early developments were encouraging and work was pressed vigorously. But soon the exhaustion of funds caused the levying of assessments and the stockholders commenced to loose courage. Almost from the outset the South Eureka seemed to take a fiendish delight in raising high hopes only to hurl them to the blackest depths. Again and again strikes were made that warranted further work, and it was finally decided to erect a mill and modern mine equipment. A few months of prosperity developed, but again values fell off and again the call went out for assessments.

For eighteen years this condition continued until even the boldest lost heart and a noted engineer was consulted. After a complete examination of the property a discouraging report was issued. For a few months the fate of the mine hung in the balance. Then the leading spirits, against their better judgment, determined to continue Many of those who had paid assessments for so many weary years, however, flatly refused to have anything more to do with a proposition that swallowed gold instead of yielding it. In numerous instances stock was given to those who would pay assessments.

TURN OF THE TIDE.

And then came the turn of the tide. About three years ago Henry Malloch, secretary of the company, became its president. Always cherishing faith in the property he determined on a final effort to compel success. From the 2,500-foot level it was decided to drive a westerly drift and explore a portion of the virgin holdings. A three-foot vein of $4 ore had been developed here, but of itself commanded scant attention. For eighty feet the drift was extended—and a big vein struck. With every recourse at its command the management feverishly pressed developments, for it was generally realized that the life of the South Eureka depended on the result. The culmination of the work demonstrated a ledge fifty feet wide carrying average gold values of $6.50 per ton. The stockholders heard and gathered courage, and a steady demand commenced to develop for the so recently despised stock. Another drift was sent out from the 2600-foot station and again the vein was encountered with its earlier characteristics prevailing. Cross-cuts were rushed from other levels and the result satisfied the owners that success had been granted them after the long and hopeless years. The stock immediately shot upwards and men found themselves on the road to wealth when all hope had been abandoned.

Within a few months the vein had been proven from surface to the 2,600-foot workings and a second orebody, rivaling the first in size and character tapped. It was evident the South Eureka was destined to become one of the great mines of the state. New equipment was provided, the working force increased, and dividends took the place of assessments. Not only did the owners of the South Eureka benefit, but the discoveries sent a wave of encouragement all over the lode and capitalists began to favorably consider mines that had lain idle for long years. The South Eureka company itself became interested in outside properties and acquired the Oneida, one of the famous old producers that had lain neglected for years after establishing a splendid record. The development of the Oneida is being carried forward vigorously and the excellent ore recently developed indicates the property will again become an important producer.

MAIN LEDGES IN SLATE.

The main ledges of the South Eureka occur in slate, with bands of soft gouge dividing the quartz from walls. The veins are gradually converging toward each other and are calculated to meet near the 3,000-foot point. In addition to the main deposits, several small shoots have been developed, with values at times running high. Values vary widely, but the average is near the $6.50 mark. The three-compartment shaft has an incline depth of 2,800 feet and is equipped with a Knight & Co. electric hoist having a capacity of four tons from a 3,000-foot depth. The four-ton skips travel at the rate of 1,250 feet per minute. A 400-H. P. Westinghouse motor supplies the energy. To take care of the small flow of water a pumping system, including reservoirs on the 2,000 and 2,700 levels, has been provided with a capacity of 200 gallons per minute. Machine drills are used in development and blocking out ore. Quartz is seperated from waste in the stopes and delivered to the cars supplying the mine skips. At the shaft collar the ore is received by a 200-ton capacity bin, with the waste placed in a receptacle containing 50 tons. The bin feeds through six improved chute gates into cars which tram the product to the mill building. The mill bin, containing 2,800 tons, feeds to eighty 950-pound stamps having a capacity of 400 tons per twenty-four hours. The plant is of the back-knee, A-frame battery type, and outside amalgamation is employed. From the plates the pulp passes to forty six-foot Frue vanners. In the past this completed the treatment for gold recovery but the management purposes to install a canvas concentrating plant to effect extraction from tailings leaving the vanners. Such concentrators are very extensively employed in Mother Lode practice and give excellent satisfaction. Mining and milling costs aproximately $2.63 per ton. The mill is operated throughout by electricity. Four Westinghouse 50 H. P. motors drive the stamps.

ANOTHER DEEP ONE.

The deepest mine on the lode, after the Kennedy, is the Argonaut. Like the Kennedy this property is located in the Jackson district and has secured greatest profits at great depth. The main shaft has an incline depth of 3,800 feet and is being deepened to the 3,950-foot point. This corresponds to an approximate vertical depth of 3,400 feet. The orebodies occur in a slate formation, with the veins stronger and less broken than is usual in many neighboring properties. In size the ledges range from twenty to thirty feet with values averaging around $5 per ton. The Argonaut is one of the oldest of Mother Lode mines, and like many other mines of this region the surface deposits were practically valueless. At the 600-foot point the first commercial

was found, but the prosperity of the dates from the rich strikes made on ,600 level. The mill comprises forty ps and usual vanner annex, the plant ig a capacity of 200 tons per day.

e of the more famous old producers is being reopened is the Keystone, Amador City. The Spring Hill of the group, at one time desig- the "Minister's Claim," was the of the first quartz discovery in the lor field, the strike being made in two years after the great California rush developed. From the first good ore was found, but swelling ground d an unexpected source of great nse, and only by herculean efforts the owners able to keep the prop- in action.

one occasion the owning company ased considerable hay from a Campo rancher. Time passed and the hay not been paid for. The indignant ner proceeded to play a card on his account. He employed the sheriff atch the mill and to seize the amal- when clean-up day arrived. The rintendent learned the officer was in icinity and suspecting a coup, calmly the amalgam down into the mine concealed it. Men of those days not prone to hesitate. Action was keynote of existance. For the ling there was no place among the y Argonauts. So the sheriff learn- f the bold plot of the mine manager ely entered the property and com- ed a search for the amalgam. The rintendent, nothing daunted, prompt- opped the pump, planning to flood the r workings and save the gold. But wary officer soon appeared at the mouth—and he had the amalgam. were the means often prevailing g owners to keep their properties ting at any cost.

1866 was made the strike that for placed the Keystone among the gold yielders of the world. East e hangingwall vein an easterly cut was driven and a new ledge, lit- y spangled with gold, intersected. year after year the property contin- sensational production, and it is of- ly recorded that 1$7,000,000 was re- ed from above the 1,000-foot point. exhaustion of the rich ore, and in- ing costs attending further depth, the subsequent closing of the Key- . A year ago new interests acquired amous old property and commenced ng the shaft to 2,400-foot point. The has advanced past the 1,800 level, ndications are considered bright for restoral of the old producer to a place among the big mines of the .

HE PLYMOUTH AND OTHERS

e Plymouth Consolidated, in the Plymouth district, is another old property recently reopened. This group is officially credited with an output of about $6,500,000. The orebody, when last worked, ranged from forty to seventy feet wide, with the principal shoot thirty to fifty feet wide. This consisted of ribbon quartz. The average yield from ore ranged from $6.18 to $7.50 per ton through several years. The main shaft, the Pacific, was sent to a depth of 1,700 vertical feet. The California Exploration Co., an English syndicate, is now engaged in reopening the old property and plans to send the shaft deeper and thoroughly prospect the lower workings.

Other large Amador producers are the Bunker Hill, Central Eureka, Fremont, Zelia and several others. As in other prominent portions of the lode, mining must necessarily be conducted on a large scale to achieve profitable results. The low grade of the ore, and the immense veins, forces the maintenance of large mills and employment of large crews of men, consequently the average Mother Lode mine is not a proposition for the small operator. But the vast extent of the veins, the excellent climate and favorable ore characteristics appeals attractivey to the man of large resources.

In the Calaveras portion of the lode, the principal mines are located in the Angels camp district. Here the Utica company has developed large bodies of milling ore below the 1,500 points in its Cross, Gold Cliff and other mines, while the Angels and other companies have aso demonstrated commercial deposits at considerable depth. Most of these properties are equipped with mills enbracing forty to eighty stamps. In the Melones district the Melones Mining Co. operates on a massive deposit of low-grade ore to a depth of 1,100 feet from the surface. This deposit is a veritable mountain of ore and has been developed principally by adit workings. The glory hole method is employed, and beneath this main orebody veins of commercial quartz have been demonstrated. The company operates a 100-stamp mill.

TUOLUMNE COUNTY MINES.

Tuolumne county boasts several fairly deep properties, but the mines hardly approach the magnitude of the large Calaveras producers, or the still more colossal Amador yielders. The Eagle-Shawmut, the largest producer, has been developed to an incline depth of 2,700 feet and is equipped with a 100-stamp plant. The App, Harvard, Soulsby, Black Oak and a host of other famous old producers still contribute to the golden yield of the county. Practically all of these are mining, or have developed, ore of profitable grade below the 1,000-foot point. In the past several years El Dorado and Mariposa county mines have established splen did records, but the cost of mining attending increasing depth, and generally limited finances of owners have militated against heavy production in the past decade.

While the glory has departed from many of the old districts, many eminent engineers predict the old mines will again command high regard when companies of ample financial strength become interested and work is conducted along modern lines. The Princeton, most famous of Mariposa producers, has yielded in excess of $5,500,000 and has been developed to an incline depth of 1,600 feet, corresponding with 1,250 vertical feet. The vein has been proven for a continual length of 1,500 feet and at the bottom of the shaft is six to eight feet wide.

All the deep mines, as depth is reckoned on the lode, are located in Amador, but there appears many good reasons why the future should record the development of properties in other counties that will compare favorably with the deep producers of Amador.

It naturally commands capital and courage to sink deep shafts through broad areas of comparatively unproductive territory with only a possibility that at depth deposits of sufficient value and magnitude will be found to reward the enterprise and initiative of operators. And only strongly financed companies are justified to pursue such steps. But the free-milling ore, congenial climate and plentitude of water and timber in most sections, are mighty factors in the future deep development of the lode in districts where operators have hitherto been fairly content with the output from comparatively shallow workings.

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The extreme solubility of nitrate salts renders it unlikely that concentrated deposits will remain anywhere except in places either not subject to or protected from the solvent action of rain, surface water, or moving ground water. Thus nitrate salts are found chiefly in caverns or caves, or under overhanging ledges, or, as in the Chilean and other South American occurrences, in a region of exceptional aridity. The assertion that none of the nitrate deposits of the character mentioned will prove commercially workable is not warranted. Such deposits have proved to be of value under exceptional conditions, as when they were utilized for the manufacture of gunpowder, during war times in the Eastern states; and it is entirely possible that changing conditions may render some of the Western deposits valuable. It must be recognized, however that, so far as may be judged from present evidence, few if any of the deposits now known warrant much outlay for development as a source of commercial nitrate salts.

HISTORY AND GEOLOGY OF ANCIENT GOLD FIELDS

By LEON DOMINIAN.*

The lack of Aryan roots for the names of metals commonly known among the Aryan settlers of Asia Minor, as well as the later colonizers of Europe, indicate that these races were generally ignorant of the use of metals until they came into contact with Semitic peoples. Practically all mining-terms in current use among the earliest Greeks resemble very strongly their distinctly Semitic equivalents, which can be traced all the way in a broad belt beginning in Lower Mesopotamia, and extending westwardly to the Syrian shores of the Mediterranean. The Greek word "metallon," for instance, used indiscriminately to designate mine or ore, probably came from the earlier Semetic equivalent, "matal." Again, the Greek word "chrysos" (gold) and "chalkos" (copper) seem to be descended from the Semitic forms "chrouts" and "chalak." It is a natural inference that primitive mining methods were evolved by the dwellers in the mineralized areas of Asia Minor, from whom later Greek, Roman, and even North European miners obtained their first notions of the reduction of metallic ores, by virtue of a general westward migration of mining and metallurgy. Some traces of its passage through Turkish territory will be noted in this paper.

While European Turkey can boast of one ancient gold-field, the Asiatic dominions of the Sultan may lay claim to at least two well-defined and widely separated gold-producing districts. These three regions may be distinguished as the Thracian, the Pontic, and the Anatolian gold fields.

THE THRACIAN GOLD-FIELD

The most conspicuous topographic feature of the lowland between Constantinople and Salonica is the uplifted Archaean mass known as the Rhodope mountains. This chain appears to be a southern prolongation of the boundary-defining Kara Balkan range, from which it extends with an approximately north-south trend until it almost dips into Aegean waters at the Gulf of Lagos. It forms the backbone of the Thracian metalliferous province, and is intimately related to gold-mining in the region. Starting from within its folds, that industry found a propitious field eastward up to the site of the placers of the Hebrus river (the modern Maritza), mentioned by Pliny.[1] On the west, gold was won as far as the banks of the Strymon[2] (the modern Struma or Karasu). These two water-courses give fairly accurate east and west boundaries of this important district on the mainland. The island of Thasos, lying west of the Rhodope mountains, to which it is petrologically related, also belongs to this operations in this region. Yet there is no reason to doubt that the aboriginal Thracian tribes were acquainted with the values of the metals found in their subsoil, and it is likely that they led enterprising prospectors from the south more than once to the site of the mineral deposits, as Indians have shown quartz and other veins to the white man in the far west. According to Greek mythological tales, mining was first undertaken on Mount Pangeum by Cadmus,[4] who settled in Thrace while engaged in his search for Europa, who had been carried off by Jupiter. Lenormant[5] claims that Cadmus in this story represents Phoenician settlers who immigrated into Thrace. The date of this beginning of what was destined to become a flourishing indus-

Fig. 1.—Sketch Map of European Turkey, showing the Thracian Gold Field.

same metalliferous province. Fig 1 is a sketch-map of Turkey in Europe, showing the Thracian gold-field.

The Thracian coast consists of highly-metamorphosed pre-Eocene formations[3] that appear to have been much dislocated, so that the general appearance is that of an archipelago of old rocks in the Eocene sea. The component rocks include mica and hornblende-schists, crystalline limestones and marbles, gneisses and granite, and serpentines, upon all of which Tertiary deposits rest unconformably.

The Phoenicians seem to have been the first to conduct organized mining try is set at 1594 B. C. by Abbe Barthelemy in "Adacharsis."[6] Other historians place it at as much as a hundred years later; but whatever be the true date, there is no doubt of the colonization of the district by Phoenician immigrants, of whom a constant procession from the southeastern shores of the Mediterranean was persistently wending its way northward.

The exact location of Mount Pangeum has not been established; but it is known to be in the range running parallel to the coast between the valley of Anghista or eastern portion of the valley of Serres and the high road from Orfano and Pra-

* Mining Engineer, New York. Trans. Am. In. of Mng. Engineers, Nov., 1911.

1 Book xxxiii., chap. 21.
2 J. Malcolm Maclaren, Gold, p. 160 (London, 1908).
3 Quarterly Journal of the Geological Society, vol. lx., No. 239, p. 243 (Aug.,1904).
4 Diodorus Siculous, Book v., chap. 48.
5 Premieres Civilizations, vol. ii., p. 321.
6 W. Jacob, An Historical Inquiry into the Production and Consumption of Precious Metals, p. 41, footnote.

' It has been called Punar Dagn ıme maps, and the old mine-workare supposed to have been found e Pilaf Tepe peak. The production ıld from this locality was large ;h to give rise to various legends : riches locked up within the bosom ese mountains. At the height of ɔower of the kings of Macedonia, ly after 400 B. C., it was the preg popular belief in this part of e that gold extracted by the pick l immediately grow again like grass d by the scythe.

s not surprising that the possession ch gold-bearing lands was ardently ed by rival Greek states. To menɔut a single case, in 465 B. C., the ians revolted from the maritime deracy headed by Athens, on acof a quarrel concerning the ian gold mines, with the Athenian rs at Eion, on the Strymon.[8] At time the Thracians were actively ng their own mines, although, acıg to Herodotus,[9] these were beıg to show signs of exhaustion. It erefore highly probable that they spurred on to investigate the posies of the adjoining mainland, and n this pursuit, their interests clashith those of others similarly occu-

At all events, the Thracians figs the principal owners of the mines d Datum, a very important mining near the coast, and once an opulent thanks to the wealth which its inınts derived from the ownership of old-mines.

ther known locality of similar inal activity lies north of Datum. s called Crenidae at first, and Philubsequently. The last name surto this day, marking the site of which the traveler cannot fail to , almost halfway between the town ama and the sea-coast. Thracian thenian miners had settled in this ty in the fifth century B.C., and while were very actively engaged ir craft. In 357 B.C., however, the races of foreign enterprise still disle consisted of scattered abandonɔrkings. The mines had reverted Thracians, who had become effete ;h the distribution of wealth acated by their predecessors. Some time in that year, Philip, king of Macedonia, marching victoriously eastward, reached Amphipolis, 30 miles west of Crenidae. His attention was directed to the mines, reports of the richness of which must have been still current. Probably in need of funds for the execution of his vast projects, the conquering sovereign did not disdain to investigate the old workings for himself. He descended underground,[10] and supervised in person by dim torch-light the cleaning out and unwatering of the "canals" (drifts). Canal is the term used by the Scotch historian, probably to conform to the Latin texts available to him. Pliny, throughout his Natural History, uses the same term to represent underground workings. Thanks to the royal initiative, the mines were soon after placed on a producing basis and the "bosom of the earth was again opened and ransacked with avidity"—according to the Scotch Historian Royal, who relies for the substance of his account on the text of Seneca.[11] It was in commemoration of this industrial revival that the town was henceforth called Philippi. The bulk of the gold extracted was coined on the spot, to the amount of nearly 1,000 talents (about $1,000,000), annually,[12] into the now exceedingly scarce Macedonian gold-pieces known to numismatists as "Philippic." This was in those days an enormous sum, having a purchasing power far greater then than now. It bears witness to the great enterprise and activity of the Mecedonians, and may also be considered as a proof of the relatively large area that must have been included in the workings, since, with the methods of extraction then in vogue, vertical depths exceeding 300 ft. must have been attained with considerable difficulty, if at all.

awlinson's Herodotus, vol. iii., p. ootnote (London, 1880.)
hillip Smith, Ancient History, vol. i., (London, 1893).
Lenormant, Premieres Civilisations, , p. 331.
Gillies, Ancient History of Greece, ., p. 33.
Gillies, loc. cit.
Diodorus Siculus, Book xvi., chap 8.
acob, loc. cit., p. 76.
Finlay History of Greece, vol. 1., pp. 7 (Oxford, 1877).
acob, loc. cit., p. 132.
ɪ. Gobet, Les anciens mineralogistes yaume de France, vol. i., p. 53.
Arrian, Fragmenta, 67.
Annales des Mines, Ninth Series, vol.

It is impossible to determine the length of the period of active mining operations, after this Macedonian revival of the industry. But it seems very unlikely that Alexander should not have followed in his father's footsteps, in fostering the industrial expansion of his empire; and we may safely assume that the mining camp of Philippi continued to flourish for about a couple of decades, at least, during the hey-day of Macedonian supremacy. Two centuries later, after the battle of Pydus, and the defeat of Perses (about 168 B.C.), the region passed into Roman hands, and contributed its share to the periodical replenishment of the Roman treasury.[13]

In Byzantine times, these gold-mines, lying at the very door of the capital, could hardly have been overlooked by the wideawake engineers of the Eastern Empire, whose knowledge and skill were unsurpassed in their age. When, in the third century A.D., Rome's universal but waning power, vested in Constantinople, made that the first city of the world, the gold-mines of Thrace were still furnishing large supplies of gold. Indeed, from that time to a period in the twelfth century, when Europe was deep in the gloom of the Dark Ages, it was the part of civilized Byzantium to provide a large part of the gold currency of the world, through a continuous supply of Byzantine gold coins, which found their way to the northernmost regions of the continent.[14]

Four centuries later, and about 3,000 years after this celebrated gold-field was first exploited, it happened to be visited by Dr. Belon of Paris, a physician of Francis I. This was at the zenith of the power of the Ottoman Empire, when French statesmen were hobnobbing with their Turkish colleagues under Sultan Suleyman the Magnificent. The doctor, who was an expert in mineralogy, examined the Thracian district in 1546 and 1549,[15] and says of it:[16]

> "These mines yield so much gold and silver that the Emperor of Turkey draws from them 1,800 ducats a month, and in some months this sum attains 3,000 ducats. Within the last fifteen years the production has declined, and the duties to the Emperor have not exceeded 1,400 ducates. The persons who carried on the operations and formerly enriched themselves more than they were thought to do at present."

From his reports it appears that the mines were located on the side of a mountain in the vicinity of the village of Siderokapso, where he found conditions similar to those which he had observed at Joachimsthal in Bohemia. The presence of a large number of miners and the consequent opportunity for trade of many kinds, had drawn a motley gathering from all lands. His enumeration of the various nationalities assembled in that mining camp vividly reminds us of the various races encountered today in any camp "out west." For their methods of mining, however, the natives had drawn on the Germans, in whose language the technical terms or operations, as well as the names of tools, were currently expressed.

THE ISLAND OF THASOS.

Facing this highly-productive area on the mainland, the pile of primary rocks constituting the island of Thasos emerges out of the Aegean sea. The significant appellation of Chrysay (the Golden), bestowed upon it by the ancient Greeks,[17] shows that the fortuitous intervention of watery expanse in no wise impared the felicitous similarity of its physical features to those prevailing on the opposite shore.

According to De Launay,[18] who has thoroughly investigated the geology of the Aegean archipelago, the island consists in the main of an extensive NW-SE, anti-

cline of metamorphic beds stretching from the hamlet of Kasavithi on its western coast to the islet of Kynira on the east. These masses of primary rocks make up exclusively a complex of metamorphic schists, including gneisses, mica-schists, and amphibolites, with intercalated strata of crystalline limestones and marbles. Such rocks are characteristic of the Aegean region both on the European and the Asiatic shores. The metamorphosed strata strike almost due E. and W., and are very frequently horizontal. Here and there, occasional layers of recent conglomerates cap the older rocks.

By reason of the variety of minerals occurring on this island, the Thracians were famous as miners throughout antiquity. These natural resources also acted as a powerful incentive to the colonization of Thasos, as early as at least fifteen centuries before the Christian era, by the fortune-seeking Phoenicians.[19] Towards the beginning of the 5th century B.C., Herodotus's travels had taken him to the island, where he found that mining was the chief industry of the natives. Indeed, the enterprising islanders had, by this time, extended their operations to the equally rich adjoining regions on the mainland, as described above. Their annual revenue from mining amounted to 200 talents (about $240,000) in lean years, and 300 talents (about $360,000) in years of prosperity.[20] About one-fiftieth of these totals was yielded by their holdings in Thrace proper. Concerning the mines in the island, the Father of History says:[21]

"I myself have seen the mines in question; by far the most curious are those which the Phoenicians discovered at the time when they went with Thasos and colonized the island, which afterwards took its name from his. These Phoenician workings are in Thasos itself, between Caenyra and a place called Aenyra over against Samothrace; a huge mountain has been turned upside down in the search of ores."

This remarkable description seems to leave no doubt as to the exact location of these mines.[22] Yet it was impossible for De Launay [23] to detect any traces of ancient workings at the alleged site. On the other hand, he discovered ample evidence of considerable ancient labor near the hamlet of Kakiracki, built on the diametrically opposite shore. At this point, old slags had been dumped into the neighboring gulches, often filling them entirely, particularly where they lead to Sotiro. The unusually large volume of these old dumps indicated the proximity of extensive workings and their prolonged exploitation.

The inference from these two sets of observations is that two distinct periods of mining activity must have prevailed at different places in Thasos, and that all the superficial manifestations of the earlier, which obviously must be the one referred to by Herodotus, in the passage quoted above, became completely obliterated in the course of time. It should also be noted that both sites correspond to homologous points on the anticline, and that mineralization of the one would, all things being otherwise equal, warrant the assumption of a similar phenomenon at the location of the other. These facts, coupled with our knowledge of events in Thrace, enable us to reconstruct the story as follows:

At some time before the 15th century B.C., Phoenician explorers, sailing from the southeast, landed in Thasos at a point near Kynira, where the outcrops of the pyritic bodies (seen by De Launay) attracted their attention. That such outcrops might be auriferous is entirely in harmony with our present knowledge of this class of deposits; and the gold-bearing zone need not necessarily be confined to the mere outcrops but might comprise all the oxidized upper levels of the ore body. The recovery of the metal would be effected mainly by means of washing and panning, although amalgamation also might have been employed occasionally, since it is now known that the properties of mercury in this connection had not escaped the attention of the ancient gold-seekers.[24] After the working of the upper levels at Kynira, and probably before any attempt had been made to invade the mainland, the surface of the island was minutely explored, and the deposit lying on its western coast was discovered and likewise made to yield its precious contents. The slags observed by De Launay indicate the use, in this district, of other metallurgical processes.

Another site of ancient exploitation is known to have existed north of Thasos, in the small island of Thassopoulos, known in the days of Herodotus as Scapte-Hyla. The annual revenue of its mines in 492 B.C. amounted to 80 talents[25] (about $100,000). One of the eminent owners of mines in this locality was the wife of Thucydides,[26] whose wealth may have enabled him to devote himself to study and literary labor.

Such is the partial record of a region, characterized by the resumption of profitable mining-operations at various intervals during nearly forty centuries. Undoubtedly much might be added by more learned and leisurely compilers to this imperfect, yet, I trust, suggestive outline. Researches into the industrial activity of former generations are not always totally devoid of economic value to the modern engineer. While many of the principles actuating ancient technical practice have now become obsolete, it may be questioned whether the faculty of reasoning upon available data and of dealing with immediate conditions has been notably increased; and the ancients, judged according to their light and their tools, may still be worthy of our study and our respect.

No work of importance has been attempted on the mainland section of this gold-field within recent years. It is interesting to note, however, that the island of Thasos has now become a zinc-producer. The annual production of calamine from mines owned by the Metallgesellschaft of Frankfort amounts to 30,000 metric tons.[27] Whether a similar change in the metal-production of the mainland deposits will hold true, remains to be determined by future observers; but it is quite possible, in accordance with anologies, that the future gold-production of these ore-bodies may not be again as abundant as it has been in the past.

ASIATIC TURKEY.

Three major folded arcs, forming as many independent chains of lofty peaks, fringe the wave-battered shores of Asia Minor, and, encircling, rim-like, its elevated barren plateaus, determine the trend-lines[28] of the structure of this westernmost projection of the Asiatic continent. Within the mighty folds of each occurs an auriferous zone, gentically related to copious lava-flows of comparatively recent origin, detailed studies of which are yet to be made.

The Pontic gold-field lies in the most easterly, and the Anatolian gold-field in the most westerly, of these zones of disturbance, the effects of which have been so far-reaching upon the development and history of the peninsula. A third gold-field, of altogether minor historical importance, lies on the slopes of the Tauric mountains, the most imposing of these three great uplifts. Fig. 2 is a sketch-map of Asiatic Turkey, showing the gold-fields.

This occurrence, within the only zones where heavy mountain-making agencies have been at work, of the only known gold-producing areas in Asia Minor, can scarcely be regarded as a mere coincidence, though it would be hazardous, at this incipient stage of our knowledge of the geology of the region, to carry our generalizations too far.

A glance at the early history of this tramping-ground of our Aryan forefathers

xiii., p. 227 (1898).
19 G. Rawlinson, Phenecia, p. 60 (New York, 1880).
20 Herodotus, Book vi., chap. 46.
21 Ibid., chap. 47.
22 This locality is probably the one called at present Kynira; it is an islet lying east of Thasos and facing Samothrace.
23 Loc. cit.
24 Pliny, Book xxxiii., chap. 22.
25 Herodotus, Book vi., chap. 46.
26 Marcelin, Vitae Thucydide, p. 9.
27 Private correspondence of the writer.
28 E. Nauman, Hettner's Geographische Zeitschrift, vol. ii., pp ? to 25 (1896).

the impression that the region was etter known and better appreciated m than by its modern inhabitants. 3,000 years ago, Asia Minor, as a habitation, was already very old, here flourished in certain portions a civilization as advanced in many phases, as the later Roman culture was.

ig with the recognition of the econ- value of various ores, mining had ed such importance as to have be- the means of sustenance of numer- settlements scattered from the n coastland to the Persian gulf. n that territory, empire after em- ad risen to power, and passed into on. Colonies of the vanished king- of Summer and Akad, preceding the onian empire itself, had flourished fifth millenium B.C. With the ard march of progress, the Hittite came into being; and finally, the nturies immediately preceding the of Christ witnessed an unparalleled n of civilization on the eastern of the Aegean sea. During this

—Sketch Map of Asiatic Turkey, showing the Anatolian and Pontic Gold Fields

Greek paganism evolved a highly- ced organized life. In each of these ssive stages of culture, the art of ng ores was profitably carried on; etals being respectively valued ac- g to their relative abundance and ness, or commercial importance.

HE ANATOLIAN GOLD-FIELD.

metalliferous province forms part geologic belt extending from the of Troy to the valley of the Pac- and slightly farther south, so as clude Mount Tmolus—the modern Boz Dagh. It contributed largely to the gold output of proto-historic times, and, as might be naturally expected, it has been duly commemorated in various legends which have descended to us, together with the superabundant exaggerations with which ancient exploits were wont to be embellished.

Its northeast portion was explored during antiquity in the vicinity of the Asiatic shores of the Dardanelles. The abundance of gold jewelry found in the excavations on the site of the several cities of Troy indicates a large production of gold from localities probably not far away. The best-known of these mining camps of the Troad flourished between Pergamos and Ataineos, and were inhabited by the Dactyles, a hardy and enterprising race. Strabo, in the course of his travels, found numerous traces of ancient workings[29] in the vicinity of the ancient town of Astyra, then a ruined city which formed part of Abydos, but which had been independent when the gold mines in its vicinity were productive. At the time of Strabo's visit, close to the dawn of the Christian era, the mines had been practically abandoned, and the formerly prosperous mining camp had dwindled to commercial insignificance. The extent of the ancient workings seen by him indicates that mining had been carried on very actively at this point, and legendary tales often attribute the immense wealth of Tantalus or of Priam to the ownership of these diggings.

The site of Astyra is supposed to coincide with that of the modern hamlet of Serjiller, about 14 miles south of the Dardanelles. Abandoned workings of considerable extent are known to exist at this point, in a mica-schist country, intruded upon by lower Tertiary igneous rocks, which according to Diller,[30] English and Flett,[31] consist of liparite, mica-hornblende, and augite-andesites, the latter in an advanced stage of decomposition. All these volcanic rocks have been ultimately capped with basalt. This igneous series is remarkably similar to some which have been observed in various zones of volcanic activity within the American Great Basin region, such as the southwestern portion of Nevada, where appreciable amounts of gold have been yielded by veins incased within rocks, the chief characteristic of which appears to consist in the intermediate composition, in a scale of decreasing acidity of the magmas from which they have solidified.

A portion of the large quantity of gold articles unearthed on the site of Troy must have been derived from Phrygia and Lydia, two of the most important mining provinces of the world in the first millenium B. C. It may be recalled here that the Troad borders on Phrygia, where, according to ancient traditions, the discovery of the art of fusing metals took place in the course of a forest fire, during which is was found that fragments of ore had been accidentally melted.[32]

There cannot be any doubt that the Phrygians, in common with their better-known eastern neighbors, the Lydians, were the most renowned miners and metallurgists during the pre-eminence of Hellenic culture. The profusion of mineral species, enumerated by Pliny as found in these kingdoms, indicates that the natives had abundant opportunities to become proficient in the arts of mining and smelting. Lydia especially was renowned for its wealthy rulers and citizens, most of whom were owners and operators of mines. Sardes, the capital, was long a world-market for gold, silver, copper, and iron. Not only did the Lydians derive large incomes directly from their underground operations, but, being situated, geographically, midway between Western culture and Eastern splendor, they managed to act as commission agents for both parties, so that products from either direction paid them toll in transit, and thus increased the wealth of the Lydian capitalists. Herodotus mentions[33] the colossal fortune, reaching far into the tens of millions of dollars, amassed by Prince Pythios, supposed by some to have been a descendant of Croesus, the wealthiest of the kings of Lydia. This nobleman was the dynast of Celenes when Xerxes invaded the West. Plutarch declares[34] that it was his custom to prevent the inhabitants of the mining districts under his rule from pursuing their agricultural labors, lest the time thus spent be subtracted from more profitable employment at underground work. We can

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ook xiii., chap. 1.
uarterly Journal of the Geological y, vol. xxxix., No. 156, p. 627 (Nov.,
dem, vol. ix., No. 239, et seq. (Aug.,
ucretius, lines 1240 to 1243.
ook vii., chap. 27 to 29.
oralite, vol. i., p. 324.

more easily understand such conditions when we take into consideration the great scarcity of metals, and the consequent demand for them, which existed at that time throughout Europe. The lack of gold was particularly felt in Greece in the sixth century B. C., when the Lacedemonians had to import expressly from Lydia the relatively small amount required for the gilding of a statue.[35] With regard to the wealth of Croesus, Rawlinson, referring to Strabo, says[36] that its reality cannot be questioned; for Herodotus had himself seen the ingots of solid gold, six palms long, three broad and one deep, which to the number of 117 were laid up in the treasury at Delphi.

The height of Lydian prosperity was attained in the first quarter of the seventh century B. C., and successfully maintained during the ensuing 250 years. Throughout this period the precious metal was won both from alluvial and from deeper mining. Glowing tales concerning the gold-producing banks of the Hermos were spread to the confines of the world; and many are the legends that spring from the accounts of the rich clean-ups made by enterprising Lydian prospectors in washing the gravels of the Hermos and its tributary, the Pactolus. The latter stream owed its gold, according to an ancient story, to the fact that Midas, the mythical founder of the Phrygian kingdom, had bathed in its waters, upon the advice of Bacchus, in order to be deprived of the fatal faculty of turning everything he touched into gold. This tradition, like so many others of a kindred nature, has value only as indicating the existence of an ancient and flourishing placer industry in the valley of the Pactolus. This river, as well as the Hermos, of which it is an affluent, rises on the northern slope of the Tmolus mountain, itself the site of numerous mining excavations. It may be safely assumed, as an explanation of these old workings, that the discovery of nuggets in the river sediments stimulated a careful examination of the immediate vicinity, and that this search led the ancient prospectors to the ultimate source of the gold, namely, to the auriferous veins of the mountain.

How prolific in their yield of the precious metals these banks of the Pactolus must have been may be inferred from a partial review of the frequent allusions in ancient literature to the gold-bearing sands of this famous river. Tchihatchaff's enumeration[37] suggests the strong appeal made by this source of wealth to the imagination of ancient writers. Among others, Scylan of Caryadnis[38] speaks of the Pactolus as having formerly borne the name of Chrysoroas (the gold-bearing), by reason of its auriferous character. He claims, furthermore, that the precious element was engendered eternally in its waters. Herodotus also alludes[39] to the gold carried by this stream; and it is interesting to note that he lay special stress on the notion that the gold was primarily obtained from the flanks of Mount Tmolus. Poets and writers in endless succession have extolled the good fortune of the Lydian prospector. Virgil,[40] Juvenal,[41] Silvius Italicus,[42] all refer in glowing terms to the gold-laden muds borne along with the flowing waters. Seneca,[43] with wonted emphasis, describes the river as inundating the fields with gold (inundat auro rura).

Nevertheless, this production was not destined to be everlasting. In Strabo's time, at the beginning of the Christian era, it had dwindled to comparative insignificance. Philostrates[44] quotes Apollonius as saying that the Pactolus was "formerly" auriferous; and, inasmuch as this celebrated philosopher was a contemporary of Nero and of Vespasian, it may be inferred that very little gold was recovered from this source at that time. The same writer advances the hypothesis of the primary derivation of the nuggets from the very rocks of Mount Tmolous, and his assertions in this respect indicate a remarkable soundness of deductive reasoning. In the light of modern theories on placer-formation, a part of their metallic contents may well have been derived from the rocks incasing the veins which, in the course of their erosion, have contributed the bulk of the metal subsequently re-deposited in the form of nuggets.

A later writer, Festus Avenius,[45] makes use of the term "auriger" in the text of a description of this affluent of the Hermos. His use of this adjective need not, however, be taken as indicative of a renewed activity of mining on the Pactolus. It may have been employed by way of reminiscence only. Such, indeed, appears to be the case in the writings of Constantine Manasses,[46] a Byzantine writer of the eleventh century; and John the Lydian,[47] a native of the valley of the Hermos, alludes to the Pactolus merely to refer to its past contributions to the world's wealth. In our own time, peasants dwelling in the vicinity of the Box Dagh are known to make a scanty livelihood by washing the gravels brought down by the rivers. But their appearance and mode of living are far from supporting a belief in the continued abundance of the yellow metal in that region. It is therefore possible that the placers of this gold field were exhausted fifteen centuries ago, although the same assertion might not be made with regard to the original sources of the nuggets discovered by the ancients.

The ambition of these early Greek miners was not confined to alluvial mining. Numerous deeper workings have been found on the slopes of Mount Tmolus. Farther north and in a similar direction from the bay of Smyrna, similar vestiges of ancient labors are to be seen on Mount Sipylus—the modern Manissa Dagh. Thomae,[48] speaking of gold-ores in the vilayet of Aidin, refers to this locality as the one from which part of the wealth of Croesus was derived. He says that the ancient workings had not been fully fathomed, although a vertical depth of 200 ft. below the crown of the hill had been reached. The same observer calls the country-rock in these mines a trachyte, which he found to be very much decomposed in the upper levels, worked by the Lydians. Small veins, cutting across the same volcanic rock, were found to carry argentiferous galena, blende, copper, and iron pyrites with gold, all with a quartz gangue. An average sample, taken from a 1-to 2-ton lot of the ore, assayed as follows: Gold, 13 dwt., and silver, 5 oz., 13 dwt. Troy per ton; lead, 7.6, copper, 2.2, and zinc, 2.7 per cent.

The Lydians could fairly claim to be the first users of coins in history. This, in itself, bespeaks the abundance of the precious metals in that richly-endowed country. It was quite natural that accumulations of gold and silver should eventually be bartered for commodities brought from all over the world to this meeting-point of the east and the west. To stamp the metals with distinctive signs, and use them as a measure of value, was the next step, and an easy one in the ordinary course of commercial transactions.

The earliest products of the Lydian mints were issued during the seventh century B.C.; and were made, not of pure gold or silver, but of a compound of both, known as "elektron," in which the ratio of gold to silver was four to one by weight. The name is supposed to be derived from the identical Greek word, designating amber, which the native al-

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35 Grote, History of Greece, vol. ii., p. 229 (New York, 1853).
36 History of Herodotus, vol. i., p. 367 (London, 1880).
37 Asie Mineure, Geog. Phys., vol. i., p. 240.
38 Apud Hudson, vol. i., p. 14, et seq.
39 Book i., chap. 93, 101.
40 Aeneid, book x., line 142.
41 Saturnalia, book xix., line 298.
42 Book i., line 158, 234.
43 Phoenissis, line 604.
44 Appolonius Tyannis, Book vi., chap. 57.
45 Apud Hudson, Descriptio Orbis Terroe.
46 Compendium Chronicum, line 6258.
47 De Magistratibus Populi Romani, Book iii., p. 258.
48 Trans., xxxviii., 222 (1898).

of those metals somewhat resemble or. A century later, gold and silver appeared; and, no doubt this e was associated with the discov- of a method of parting the two s. Gold and silver generally occur ure in alloys of various proportions, haracter of which is particularly it where the veins containing them he ultimate manifestations of vol- activity. The Anatolian gold-field, nstance, belongs to such a region lcanism, where gold-bearing veins, ring in igneous rocks, carry a note- y amount of silver. But, apart from xtreme manifestations, the general menon is, that metallic gold occurs ture generally alloyed with silver not with copper). So universal and ell-recognized is this phenomenon, the distinguished mineralogist, haupt, professor of that science at erg, classified native gold and native as one species, ranging in com- on from gold with a trace of silver ver with a trace of gold, and de- the occurrence in nature of either without some alloy of the other. proportions of the two metals in na- alloys vary with the composition of inerals from which they have been ed. It seems probable, therefore, the "elektron" of the Lydians was y the native alloy characteristic of own district, and was adopted for ge and commerce until the discov- f a method of parting permitted the facture of gold and silver coins sep- ly.

THE PONTIC GOLD-FIELD.

the northeastern portion of Asiatic ey, and at the point of junction of empires, the snow-capped peak of a Tertiary volcano, familiarly known ount Ararat, rising in majestic lone- above all surrounding eminences, s the center of a region charac- d by repeated volcanic eruptions, he point of intersection of two main of high uplift. One of the latter s westwardly, to form a long moun- chain which borders all the north- rn shore of Asia Minor, and within gold-mining has been actively car- on since proto-historic times.

interesting clue to these very nt operations is afforded by the text portion of the second chapter of sis (vv. 10-12):

d a river went out of Eden to water gardens; and from thence it was l, and became four heads.
e name of the first is Pison: that which compasseth the whole land of Havilah, where there is gold;
"And the gold of that land is good; there is bedellium and the onyx stone."

By many Bible students, the river Pison has been identified as the modern Tchoruksu, running generally parallel to the east-west extension of the coast. Its valley has been since time immemorial a region of exceeding fertility, and has also enjoyed, thanks to the sheltering barrier formed by the elevated Pontic range along the northern bank of the river, the added blessing of immunity from the ravages of the bleak northern gales of Russia. It is not surprising that the combination of such advantages awakened desire for their possession in ambitious leaders of different periods; and many are the tales of struggle and bloodshed over the ownership of these gold-fields.

One of these stories is repeated by Strabo,[29] whose explorations of the then known world, at a time when traveling was beset with innumerable difficulties, have made his name illustrious among students of the geography of antiquity. It appears that Alexander the Great, perhaps remembering his father's successful mining-ventures in Macedonia, received intimations of the abundance of gold in the Sambana district, which lay in the province of Syspiritides (the modern Izpir), within the Pontic productive area. Straightway he dispatched Menon, one of his generals, at the head of an armed force, commissioning him to secure possession of the wealth-yielding territory. The sturdy natives, however, resisted the great conqueror's designs regarding lands which they justly regarded as their own, and having routed the invaders, sent back to Alexander the head of Menon, his general.

Some eight centuries later, gold-mines south of the harbor of Trebizond, in the same district, became the subject of dispute between Justinian, the mighty Byzantine emperor, and Chosroes, the king of Persia, his foe.[30] At that time the workings, operated on a very extensive scale, were furnishing abundant supplies of the precious metals for the mint at Constantinople. Much of this gold was won from placers along the banks of the Tchoruksu and its tributaries, the latter having their sources in the southern facets of the Pontic range.

Strabo's copious notes here become again instructive.[31] He says that the natives recover gold by first straining the auriferous muds through screens and subsequently spreading the undersize over sheepskins specially selected on account of their long fleece, the shreds of which would serve to entangle the particles of metal. Incidentally, it may be noted that the derivation of the appellation "Land of the Golden Fleece," by which this northeastern portion of Asiatic Turkey was designated in the oldest of the tales of Greek mythology, becomes self-suggestive. The corroborative testimony supplemented by the name of Cape Jason, applied to a nearby promontory, tends to remove all shadow of doubt regarding the exact location of that once-famous Eldorado.

The period of its original discovery, however, cannot be determined as closely as its location. The earliest known record is the mythical narrative of the Argonauts in search of the Golden Fleece; and this story yields but a single credible fact—namely, that, at some time in early Greek history, not unlikely about 1000 B.C., yet perhaps a few centuries later, a band of adventurous Greek emigrants decided to set forth and discover the country from which they had received from time to time reports of the existence of untold wealth in various forms.

There is no doubt that from that time on, and far into the fifth century B.C., the various Greek communities were actively engaged in the exploration and colonization of the regions lying east of their mainland. Such expansions in the course of a national growth have invariably been the consequence of prosperity at home. It is not inconceivable that some of the hardier and more indefatigable of these explorers surmounted the hardships attending travel on the turbulent waters of the Black Sea, and succeeded in reaching portions of its southeastern shores. What they saw there may be inferred from the tales which they brought back, enriched with the adornments required to fire the imaginations of their countrymen.

According to the version of Pliny,[32] Strabo's younger contemporary, and one of the best known naturalists of antiquity, the Colchis, as he calls the Land of the Golden Fleece, was ruled, previous to the coming of the Argonauts, by Selances, a descendant of Aetes. This ruler is said to have discovered extensive gold-placers in the territory inhabited by the Suanes, who lived within the pale of the Colchides. "The whole country, however, is renowned for its gold-fields," is Pliny's final comment in connection with this description.

PROSPECTS OF THE FUTURE.

To our own generation the point of greatest interest in connection with any of these gold-fields lies in the possibility of a resumption of exploitation of the hitherto abandoned workings. This does not necessarily imply that gold will again be the chief metal recovered. There have been numerous instances where mines, at one time gold-producing, have eventually turned out to be

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Book xi., chap. 14. 19
Gibbons, Decline and Fall of the n Empire, vol. iii., p. 579.
Book xi., chap. 2.
Book xxiii., chap. 15.
Eng. & Ming. Journal, vol. lxxxix., , p. 713.
Mng. & Scientific Press, vol. xcviii. , p. 821.

great producers of copper. Two noteworthy instances of such a sequence are furnished by two of the world's present deposits of low-grade copper sulphides: the Mount Lyell mine in Tasmania, and the Rio Tinto in the Spanish province of Huelva. The former came into prominence in 1881, and began to attract attention as a gold-producer in the incipient stage of its development.[53] With regard to the latter, Strabo, to whom frequent reference must perforce be made in connection with ancient mining, has given us an enthusiastic account of the gold-production in southern Spain on the site of what are now the famous and immensely productive copper-mines of Rio Tinto.

Another instance of the same nature occurs at the Mount Morgan mine in Australia. Here the ore at very shallow depths was rich in gold and carried only insignificant quantities of copper. Lower down, however, the percentage of the latter metal grew considerably higher.

There are some signs of the recurrence of the same phenomenon in the Pontic gold-field. Copper has been mined during the past few centuries at various points within this metalliferous province. Although these operations have been desultory, there is ground to suspect the existence of a rich copper-belt parallel with the northeastern coastal development of Turkey in Asia. Kerassons is, among others, a noteworthy locality in which copper-ores in large bodies have been reported on various occasions.[54] The recovery of gold as a by-product in the smelting of such ores is by no means impossible.

Work on the Anatolian gold-field, on the other hand, has remained practically at a standstill since the beginning of the Christian era. Perhaps detailed investigation of the region will lead to interesting industrial developments; and, while these ancient gold-fields may never again yield such quantities of the precious metal as they gave to the miners of antiquity, they may produce, through development at lower depths, of the baser metals, a greater treasure than they conferred on former generations.

PROSPECTING THE YUKON

The "cheecaco," or newcomer, entering the Yukon to prospect should receive a little preliminary instruction before launching into the wilderness, says Robert Henderson, discoverer of gold in the Yukon Valley, in a letter to the Dawson Weekly News. He cannot start into the Yukon to spend the winter without enough money to defray the cost of a winter's outfit. If he leaves Whitehorse in the summer, the trip down the Yukon river may be made by steamer or in small boat. It always is easy to arrange accommodation. By buying in a Canadian town, goods entering the Yukon will not be subject to duty, but it is best, all things considered, to buy an outfit in Dawson; or, for one not coming into Dawson, to buy at Whitehorse. By buying in this territory, he has the benefit of experienced and scrupulous traders, who know just what is adapted to this region, and who will assist in selecting the best for the peculiar work to be undertaken.

The prospector should leave Dawson in August or September. At this time the summer floods are over, flies are less troublesome, and game and fish are plentiful. Whenever possible, the prospector should go by boat. (For shallow, swift and narrow rivers, a boat 30 feet long, of 26-inch bottom, and 22 inches deep is the best. Having procured his boat, 150 feet of ½-inch hemp rope, and a pair of rubber boots, the prospector next selects and loads his provisions, always bearing in mind that articles less likely to be damaged by water hould be placed in the bottom of the boat.

The outfit for twelve months should comprise the following: Flour, 500 lbs.; rolled oats, 150 lbs.; cornmeal, 50 lbs.; beans, 7 lbs.; sugar, 125 lbs.; Lubeck potatoes, 60 lbs.; butter, 50 lbs.; apricots, 25 lbs.; prunes, 25 lbs.; apples, 25 lbs.; milk, 2 cases; cream, 2 cases; ham, 25 lbs.; bacon, 50 lbs.; salt, 15 lbs.; pepper, 1 lb.; syrup, 5 gallons; baking powder, 2 lbs.; baking soda, 2 lbs.; yeast cakes, 6 boxes; soap, 12 lbs.; best pilot bread, 30 lbs.; candles, 2 boxes; tobacco; best woolen underwear, 3 suits; thick overshirts, 3; thick woolen sox, 12 pairs; German sox, 2 pairs; woolen pants, 1 pair; overalls, 3 pairs; felt shoes, 1 pair; rubber shoes, 2 pairs; moccasins, 3 pairs; insoles for moccasins, 6; snowshoes, 1 pair; pack straps, 1 set; eyeglasses, colored, 1 pair; good field-glasses, 1 pair; reliable compass; fur robe; fur cap; canvas jacket; sweater; axes, 2; small camp ax; auger, ½-inch, 1; crosscut saw, 4 feet; whipsaw; jack-plane; nails, 15 lbs., 10-penny; clawhammer; flat files, 2; sheath knives, 2; three-cornered files, 2; sharpening stone; picks, 2; shovels, 3; gold-pans, 2; Yukon stove with oven or drum; 30-30 Winchester rifle; good shotgun; 200 rounds for shotgun; 200 rounds for rifle; frying pan; knife, fork and plate; small pots, 4; large enameled mugs, 2.

The outfit should include a small medicine chest, among the contents of which should be one box of carbolic salve and a half-pint bottle of peroxide of hydrogen or other equally good antiseptic. One gallon of concentrated lime-juice should be taken along to make a pleasant and invigorating drink, and it will be a most effctual preventive of scurvy. The tent should be 10 by 12 feet in size. It serves, when not in use, to cover the outfit, a precaution that should never be neglected either in the boat or in camp.

The prospector will have no difficulty in providing himself with fresh meat. The country abounds with moose, bear, caribou, mountain sheep, geese, ducks, ptarmigan, partridges, and grouse, and cranes and swans alight on the bars of the upper rivers by the thousands. Beaver, land otter, marten, lynx, wolf, fox, wolverine and other fur-bearing animals are plentiful around the upper reaches of Yukon side streams.

On the trail in severe weather, always make camp while there is plenty of daylight. Never travel in foggy or stormy weather; always have matches and dry birch-bark ready to make a fire quickly. Eat regularly, even if you are not hungry. Keep your hands and feet dry, and —don't forget your tobacco.

It is well on a trip of this kind to take two or three good dogs and a Yukon sleigh. The dogs cost little to feed in a game country. The sleigh can be packed in the boat and will be useful for moving camp from creek to creek. Make a good warm shelter for the dogs and feed them at night.

To keep the outfit while in camp, cut four trees a few feet apart and 12 feet from the ground. Pick off the bark, and build a platform on top and let it extend about three feet on each side beyond the supports. Place supplies on top and cover with canvas and spruce boughs. They are in this way protected from animals.

In building a cabin, make it big enough. It takes little longer to build a cabin 16 by 12 than one of less dimensions, and this is large enough for all requirements. Level off the ground, and let the first logs be imbedded in it. Cover well with moss and lay the next log on top, and so with each log until the walls are six feet high. The logs forming the gable must be pinned together with 1½-inch wooden pegs, and the ridge-pole laid in place. A smaller log on each side of the ridge-pole further supports the roof, which is made of poles three or four inches in diameter, laid side by side and covered with moss and earth. Whipsaw a few boards to make a door. Pieces of moose skin make good hinges, and a clean flour sack steeped in melted tallow or oil makes a good substitute for glass.

Your partner on a prospecting trip should be a man with whom you are well acquainted, and of jovial and optimistic disposition. Avoid arguments, especially of a religious or political nature, and the golden adage, "A kind word turneth away wrath," is nowhere so forcibly realized as in the wilderness.

HE GREAT COBAR MINES

MINING & ENGINEERING REVIEW.

t to Broken Hill, Cobar is the most tant metal mining center in the of New South Wales, and the fu- f the town and district is wrapped the fortunes of the Great Cobar. The mines owned by this company e Great Cobar Cobar Gold (Fort e), Chesney Copper, and, some six farther south, the Peak and Con- r gold mines. Midway between the Cobar and the Peak is the Occi- gold mine. Apart from the fore- any other mines in the immediate y are either unworked or operat- a very small scale.

predictions of Mr. H. C. Bellinger, neral manager, are that the annual ction of the mines will shortly 10,000 tons of copper, 50,000 ounces and about 250,000 ounces silver per . For many years the Mount Bop- M. Co., at Canbelego, some thirty from Cobar, held the record as the t gold producer, but now that the om the Fort Bourke mine is being d, the Great Cobar, Ltd., holds the of place, both in regard to copper old. The following table shows the t during the last six years:

PUT OF GREAT COBAR MINES.

	Ore raised.	Blister.	Value.
....	198,168	4,030	....
....	167,005	3,459	....
....	234,877	5,127	334,251
(10½ mos.)..	203,746	4,855	378,842
(10½ mos.)..	298,652	6,248	524,000
....	346,303	6,548	366,688

n 1876 to end of 1911 the produc- f copper stands at 89,009 tons.

rder to show that the returns are y increasing, the figures for the ve months of the present year may oted:

	Copper. Tons.	Gold. Oz.	Silver. Oz.
y	423	2,250	16,751
ary	504	2,180	13,767
....	576	3,920	23,716
....	583	5,147	32,744
....	701	5,137	21,561

main shaft at the Great Cobar s down to a depth of 1,400 feet. nensions are 15 feet by 8 feet, in compartments, two of which are uling, and one for pumping, air and ladder way. The shaft is ed with a pair of coupled horizon- pansive non-condensing Corliss winding engines by Andrew Bar- Sons. Cylinders, 22-inch diam- 48-inch stroke; winding capacity, feet per minute, with a two-ton ore. The drums are 10 feet in diameter by 4 feet, and are fitted with steam released friction clutch and hand brake.

The head gear is 67 feet in height to the center of the winding sheaves, and is constructed of steel sections. Each cage lifts two 16 feet cubic feet capacity, box pattern mine trucks to the brace, and lands on chairs. The trucks are then pushed over the bin and tipped by means of a rotary tippler into the brace bin, which holds 450 tons. From this bin the ore is fed through pneumatically operated doors to two Hadfield-Hecion gyratory breakers, then over the picking belts and into the bedding bins. From here it is moved by wagons, and a small portion from each wagon is loaded into a special truck, which, when full, is delivered to the sampling mill.

The Sample Mill.—The ore is delvered to a Babcock and Wilcox tray conveyor of the endless chain end discharge pattern, having a capacity of 50 tons per hour at 45 f.p.m. This delivers onto a similar conveyor rising at an angle of 20 deg. This conveyor delivers to a No. 5 McCully gyratory ore discharger into a 30-ton capacity steel hopper ore breaker. The ore is then lifted by a belt elevator (66 feet centres), which delivers to a 64-inch Simplex sampler, 15 per cent cut. The sample then gravitates to a No. 3 McCully crusher. This delivers to a 44-inch sampler, 20 per cent cut. The sample then gravitates to a 24-inch by 14-inch rolls, 69 r.p.m. It is again sampled with a 28-inch sampler, 15 per cent cut, and again passes to another set of 24-inch by 14-inch rolls, 144 r.p.m. The product then passes to a 28-inch sampler, 15 per cent cut, and from there gravitates to a sample grinder.

Before briefly describing the smelting equipment, a few words may be written regarding the company's mines.

MINES OF THE COMPANY.

The Great Cobar Mine.—According to Mr. J. E. Carne (assistant Government geologist), the Cobar lode consists of three lenses, extending in a N. 10 degree W. direction, with a slight dip to the east. The center or principal lens has an average length of about 45 feet, and a depth of about 70 feet (the maximum being 120 feet at the 800 ft. level). The north lens is separated from the center by 140 feet of mineralized slate carrying low-grade ore. Its length, so far as proved, is 300 fet, and its width 90 feet. The south lens is separated from the center by a blank of about 50 feet in the upper levels, but merges into it below No. 3 level. Its width averages 50 feet, the maximum being 75 feet in No. 7 level and its greatest length 150 feet. South of this lens the ore dies out in country, though slight metal values and quartz leaders continue in the rubbly channel slate.

The ore lenses are simple impregnations and replacements in slate and fine sandstone, with more or less quartz in place. Iron and copper sulphides occur solid for the most part, but are occasionally mined with slate and quartz, the north lens being especially basic even where low in copper. No true eastern wall exists, the ore dying away gradually in the country, and in the mineralized slates between lenses. A marked distinction, however, is noticeable between the channel slate and the west country, the latter being more jointed and blocky.

During the reorganization of the surface plant, development work underground has been pushed ahead, and the ore reserves exceed 2,000,000 tons, averaging 2.6 per cent copper and 1 dwt. gold.

The Cobar Gold Mine.—The next most important mine, although the most recently secured, is the old Fort Bourke, purchased from the Cobar gold mines in 1910 for the sum of £120,000. The Cobar Gold Mines, Ltd., was registered in 1896 and reconstructed in 1898. The plant included a mill of 100 stamps, and, when the ore became too refractory to treat by amalgamation, something like £80,000 was frittered away in fruitless experiments. When the company shut down the ore reserves amounted to 141,053 tons, assaying 1.3 per cent copper and 10.5 dwts gold. The ore is now dumped into large storage bins and railed to the smelters as required. The total output of gold to the end of 1907, according to official returns, was 113,509 ounces, valued at £351,101, and the present production is approximately 3,000 ounces per month.

The ore reserves total some 350,000 tons, averaging 1.5 per cent copper and nearly 10 dwts gold. No dividends were ever paid by the old company, but the mine will go a long way towards providing an adequate return to the present holders.

The Chesney mine was originally worked as a gold proposition, and a large quantity of the auriferous slate from the oxidized zone was treated by battery and amalgamation, the outcrop betraying no evidence of the copper ores below. In 1901, about 4,500 tons were treated at the Great Cobar smelters, for a return of 3 per cent copper and 1 dwt. gold per ton; and in 1904 the property was purchased by the present owners. The shaft is 800 ft. deep. At the 464-foot level the ore body has been worked for a length of over 800

feet, with an average width of nearly 40 feet. The Fort Bourke ore, being richer in gold, now forms the main siliceous flux, and consequently the reserves at the Chesney mine are not being extracted on a large scale. The ore reserves total 750,000 tons, averaging 2.7 per cent copper and 1 dwt. gold. The value of the Chesney southern ore body at Nos. 6 and 7 levels south is, however, nearly 4 per cent copper and 6 dwts. gold.

The Peak mine s also a valuable property, and has been a consistent producer for the past eighteen years. Last year what is apparently a continuation of the lode was discovered, containing high gold and silver values. Further development work is being carried out to determine the tonnage available. All the mines are under the management of Mr. Nicholas Treloar.

SMELTING DEPARTMENT.

There are four blast furnaces, each 240 inches by 56 inches, at the tuyeres, with a total capacity of 2,000 tons per day, although at preesnt the average does not exceed 1,250 tons. The proportion of ores from the various mines used in the furnace charges is approximately four parts of Cobar ore to one part of siliceous ores from the Cobar Gold, Chesney or Peak mines. No ordinary furnace slag is used on the charge, but the converter slag is retreated to recover its values. When the scheme of reorganization is complete, and production on a large scale commenced, the output will perhaps exceed the figures mentioned by Mr. Bellinger. The only other factor is the price of copper, and at anything like present figures large profits can be earned.

There are two tiers of water jackets, five upper and five lower, 10 feet by 4 feet, with 5-inch water space on each side, and one upper and one lower at each end. The bussel pipe supplying 40 tuyeres is 34 inches in diameter, whilst the blast main is 42-inch diameter. The height from ground to tapping floor is 8 feet 6 inches; from tapping floor to charging floor, 26 feet 6 inches; from charging floor to top of superstructure, 16 feet 3 inches; from top of superstructure to top of auxiliary stack, 34 feet; from top of superstructure to top of down-take, 19 feet 6 inches; from ground to top of auxiliary stack, 85 feet 3 inches.

The furnace charge cars are 34 and 44 cubic feet capacity. They are hauled up the incline by a motor-driven geared winch, capable of hauling eight tons up a gradient of 1 in 8 at the rate of eight tons per hour.

The molten metal from the furnaces is continuously run into forehearths or settlers. Originally, five circular settlers, 18 feet in diameter and 4 feet 6 inches deep, capacity when lined 389 cubic feet, were installed, but now only two of this type, those at the extreme ends, are retained. Between the furnaces, where one circular settler was formerly used, two of the oval type has been placed, making a total of eight. The dimensions of these latter are 9 feet 6 inches by 4 feet 6 inches, capacity 270 cubic feet. From these forehearths the slag forms a continuous flow on the east side, delivering into slag pots. The matte is tapped intermittently on the west side (which is the converter building) into eight-ton segmental matte ladles.

There are four standard improved Berg cinder cars, 200 cubic feet capacity, 80,000 pounds capacity, fitted with automatic couplings. The slag pot is supported directly within the C.I. trunnion ring, and is tipped to either side of the track by forged worm and cut gears electrically operated. There are also three Dewhurst's patent side-tipping slag ladles and cars, with split ladle. Capacity of ladle, 280 cubic feet.

The converters are of the barrel type, 84 inches by 126 inches, carrying 14 tuyeres. There are three blowing stands, set end to end, and blowing into a common flue, with dust chamber inserted along the flue. The gases from the converter pass into hood; from hood into C.I. flue; from C.I. flue to dust-settling chamber to brick down-take; then through underground flue to fume scrubber; from scrubber to brick stack. The converters are handled by two forty-ton electric overhead cranes manufactured by Messrs. Babcock & Wilcox, Ltd. These cranes will hoist 40 tons at 16 feet per minute. Transverse traveling, 110 f.p.m.; longitudinal traveling, 250 f.p.m. Span of crane, 49 feet 8 inches, center to center of rails. Height from ground to top of crane rail, 36 feet. Crane controlled by driver in cab, traveling with main girders. Each crane is fitted with an auxiliary hoist of five and ten tons capacity.

Mr. F. J. Murphy, who has had experience on all the principal smelters in the United States, is in charge of the furnaces.

POWER GENERATION.

The power generating station is not by any means the least important section in such an undertaking. The boilers, numbering six, each having a heating area of 3,580 square feet and a grade area of 70 square feet, are of the Babcock & Wilcox make, fitted with chain grate stokes and superheaters. The coal is unloaded direct into a steel hopper, the top of which is at rail level. This hopper feeds direct into a B. & W. four-roll coal crusher, from which the coal gravitates to the rotary feeder, which feeds a B. & W. standard gravity bucket conveyor. This conveyor elevates the coal over steel hoppers, set over and in front of the boilers, which deliver through doors to the mechanical stokers. The conveyor buckets are dumped by means of mechanical dumpers over any of these hoppers. The conveyor then returns under the boiler-room floor, where the ashes are loaded into same. When ashes are being loaded all the buckets are dumped over the ash hopper, which delivers into railway wagons.

Steam is supplied to three Browett-Lindley forced lubrication, three-crank, three-cylinder, triple-expansion, vertical engines, each of 250 i.h.p. They are directly connected to three Siemens' three-phase alternators, each 300 kw., 355 k.v.a., 440 volts, 50 periods, 375 r.p.m., directly coupled to F type, direct current exciters, to supply the necessary excitation current for the above alternators at 100 volts.

Direct current is supplied by two three-phase sychronous motors, fitted with slip rings, at 380 r.p.m. on a 440 volt, 50 period circuit, direct coupled to two compound wound, continuous current generators to give 250 k.w., or 1,040 amperes, at 240 volts. This current is used for the electric locomotives, winding winch, lighting, etc.

The blast for the funaces is supplied by four Morley's patent horizontal tandem compound engines coupled to two Connersville special smelter blowers, 48 inches by 78 inches by 96 inches, and with a capacity of 36,000 cubic feet of air per minute at a pressure of 42 ounces per square inch. The converters are supplied with air by a Walker Bros.' cross compound Corliss engine, coupled in straight line with direct acting reciprocating blowers. The capacity of this plant is about 9,000 cubic feet of air per minute, at a pressure of 36 to 48 ounces.

There are two air compressors in the same building for supplying power underground and to a number of pneumatically operated hoists and other devices about the surface plant. These are also by the firm of Walker Brothers, Wigan, England. The i.h.p. of each engine is 350

SUMMARY OF COSTS PER TON.

Cobar mine, 1908, 8s 11:30d; 1909, 8s 4.08d; 1910, 8s 7.25d; 1911, 9s 5d.

Smelting, 1908, 11s 4:30s; 190, 9s 4.10d; 1910, 8s 9.36d; 1911, 7s 5.26d.

Converting, 1908, 2s 2.61d; 1909, 2s 7.20d; 1910, 1s 9.24d; 1911, 1s 8.62d.

It may safely be assumed that the figures for the current year will show a reduction on those above quoted, bringing the operating cost below 18s per ton.

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CONTENTS:

ON THE RAGGED EDGE

On the 15th of the present month, according to a report brought in from Bingham, two of the Utah Copper Company's steam shovels were "shot off their perches" on the precipitous mountain side and hurled several hundred feet down into the "big pit," which is evidently a catch-all for everything that fails to stick on the ledges above, where the enlightened "greaser" blasting crews are said to be rapidly effacing all traces of the stripping levels in their efforts to provide broken rock of some sort to the company's mills. And this suggests the thought that the management might conserve its "stripped resources" and the means of getting at them—for a time, at least—by taking the shovels around on the Wall side of the hill and utilize them in scooping up the millions of tons of rock previously there deposited and sending that to the mills. It could be "sweetened up" with Boston Con. and Barnsdall underground ore (if there is any recoverable quantity left) just as the product from the "stripped area" has been sweetened, and probably make just as good a showing. Present exigencies would seem to justify a trial of th

MESSRS. GUGGENHEIM ARE SEEING THE LIGHT

Congratulations to Daniel Guggenheim and his intimate associates, for the manner in which they are casting aside the vainglorious notions and schemes of "banker and brokerage-made" engineers which have burdened their careers in the world during the past five or six years, seem to be in order. Of course, they have taken but few steps in the new direction as yet, but news of the past few weeks indicates that they have finally seen a new light and that their emergence from the current that was swiftly sweeping them toward the maelstrom in which public contempt and financial oblivion seemed waiting to engulf them, will take place with accelerated speed from now on.

Until just recently, it has been common talk for a long time that the latest Guggenheim flotation—the Braden Copper Company—was in danger of collapse; that the proposition had had FAILURE stamped upon it in large letters. The same extravagant schemes for mining and the same or similar methods of ore-dressing that was characterizing the malpractice and administration of other propositions in which they had become largely interested in this country and in Alaska, were being applied in South America, and while claims of success were being hurled broadcast, these claims and the accompanying intimations that much additional financing would be necessary before the dividend period could be reached, did not fit well together. The public was suspicious, and Braden's star was not twinkling very brilliantly. A big milling plant was constructed and started on its career, but the grade of product turned out and the percentage of recovery of the copper contents of the ore were alike unsatisfactory and discouraging.

Recently there must have been a shaking up in the company's policy for announcement was made that a new process of treating the ore was to be tried out at the mill and that much was expected of it, comparatively speaking. From time to time reports of progress have been made and now—during the past month—the good news has been coming that through the application of the new methods success is assured. In an article dealing with the company's affairs the Boston News Bureau of the 18th, it is said:

> The Mineral Separation Company's process which has been installed in several units of the mill has given satisfactory results and should materially increase the extraction. Braden's recovery has been running as low as 50%, while the Seperation Co. promises 85%. Shortly after the first of the coming year, the Braden plant should have been so altered and remodelled as to permit of the treatment of 3000 tons of ore daily.

Now that the Messrs. Guggenheim and their associates have displayed courage enough to make radical changes at the Braden, and to such good purpose, the thought suggests itself that there is still hope that something may be done to save Utah Copper from going the remaining short distance on the direct route to Hades. Of course, it is hard to conceive how the management can be persuaded to make changes and introduce methods and processes into the Magna and Arthur mills that were not worked out and "perfected" by the company's own peerless engineers; but maybe the Messrs. Guggenheim, who own about one-fourth of the company's issued shares, can wield influence enough to force action. Accomplishments at the Braden ought to point the way.

Another evidence that the Guggenheims have tired of the game they have been forced to play in conjunction with a combination of manipulators, is also found in the Bureau of the 14th instant. The announcement, printed in part herewith, shows that the Guggenheims have joined Albert C. Burrage, of Boston, in the handling of the latter's copper enterprise at Chuquicamata, Chile, and that methods of treating the ore are being worked out without consulting the great engineers who have brought stagnation to the market in other propositions heretofore thought so much of by them. Concerning the new Chile enterprise the News Bureau says:

> The mines are situated on a plateau 100 miles east of the port of Antofagasta, and are already provided with railway facilities through a six-mile branch of the main line of the Antofagasta & Bolivia Railway.
>
> Some of these mines were first taken under option by Mr. Burrage in London two years ago, and since that time he has secured all the additional necessary mining property in the district, and suitable mill sites, limestone and native sulphur deposits; a concession to take fresh water from the San Pedro river; and also all the available water power rights

amounting to some 30,000 horse power, on the Loa river, twenty miles from the Chuquicamata mines.

The Chuquicamata copper deposit is very large and most unusual in character, its clearly-defined, uniformly-mineralized surface covering an area 8000 feet long and over 1000 feet wide. The ore is one of nature's freaks, being composed, at the surface at least, almost wholly of the basic chloride of copper called "atacamite," after Atacama, the Chilean province in which it is found, the ordinary sulphate of copper, called chalcanthite, and the basic sulphate of copper, called brochantite.

For many months six churn drills have been at work drilling the deposit, but no statement has yet been made as to what the drills have disclosed or as to the tonnage or copper contents of the ore. It is fair to assume, however, that both are at least of fair grade, inasmuch as the property has now been bought and paid for.

This property has been known to the copper world for many years and has caused much discussion among mining engineers and metallurgists on account of the peculiar nature of the ore, which is unsuited to direct smelting on account of the loss of copper through volatilization, due to the chlorine in the ore, and is also, on account of its fineness, unsuited to ordinary mechanical concentration.

It is, however, especially adapted to leaching.

The deposit has also hitherto been considered difficult to handle because situated in a desert fifty miles away from any available water supply, and, because, owing to the scattered Chilean ownership, it was practically impossible to raise money for piping, in a large way, the water from the mountains across the desert to the mine.

The altitude is 9500 feet above sea level, and the climate is very healthful, snow and rain being practically unknown.

The property is especially suited to steam shovel mining, for the ore comes to the surface without any capping of non-payable material, and is easily broken down, its local name being "llampera," which means a friable ore.

It is understood that both Mr. Burrage and the Messrs. Guggenheim have separately spent much time and money in working out satisfactory methods for treating the ores.

The property is now being conveyed to the Chile Exploration Co., which will be a close corporation, owned and officered solely by the firm of M. Guggenheim's Sons and Mr. Burrage. Daniel Guggenheim will be the president and Mr. Burrage vice-president. It is also said that neither the American Smelting & Refining Co. nor the Guggenheim Exploration Co. are in any way interested in the enterprise and that no public or private flotation of the company will be made.

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WORK AT ALASKA GOLD MINES

George O. Bradley, consulting engineer for the Alaska Gold Mines company, returned from a trip to Alaska about the middle of the month. Commenting on his return and in quoting him, the Evening Telegram of this city says: "In all $3,000,000 is to be spent by the mining company in PREPARING to develop its properties in Alaska. Todate, according to Mr. Bradley, more than $1,000,000 has been expended." In another portion of the interview the paper makes Mr. Bradley say: "Everything is UNDER COVER for the winter, but we are PREPARED TO BEGIN WORK in the spring in earnest." In opposition to this, the Boston Market Letter of Hayden, Stone & Co., of November 1, says: "Five hundred men are now at work in the various divisions of this property, developing the mine underground and doing the surface construction and development work preliminary to the erection of the company's 6000-ton mill. * * * A crew of experienced tunned men has been secured and the driving of this (the Sheep Creek) tunnel, which will be one of the main pieces of development work, WILL BE PUSHED WITH ALL EXPEDITION." All of which is "hot dope," any more than some arrangement ought to be made by which reports can be made to jibe. And for fear that you "investors" will not realize fully just what you are buying, when you get into this proposition, let us suggest that you again read the "report" of Messrs. Jackling and Holden, once more reproduced on another page of this issue.

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MAMMOTH MILLING PLANTS

So much is written and said about the mammoth capacity of the concentrating mills of the Utah Copper company, at Bingham, that an impression prevails everywhere, almost, that they are the biggest things of the character in this country. A capacity of 12,000 tons a day is claimed for the Magna plant and 8,000 tons a day for the Arthur. This means a total of 20 000 tons in twenty-four hours for the combined output.

Beginning on page 67 of this impression is an illustrated article describing the concentrator of the Oliver Iron Mining company, at Coleraine, Minn., and the plant of the Wisconsin Steel Co., at Nashwauk, Wis. The former of these mills works up 35,000 tons of crude ore in twenty hours, which is just about double the capacity of the combined mills of the Utah Copper company. Taking the output of the two mills described, and it is seen that the capacity is much more than three times as much as the combined capacity of the Magna and Arthur mills.

Of course, in the concentration of the iron ores no resort is made to fine grinding, such as that done at the Utah Copper mills. But seeing that the latter company is always prating about the immense tonnage it handles, and, as the practice followed only results in a recovery of about one-half of the copper contents of the ore, why would it not be a good scheme to throw out the fine grinders and adopt the Oliver Iron company method? The capacity for tonnage thus secured would sound well in the stock market and the results attained in the matter of recovery would probably be about the same.

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IN IMMACULATE ROBES

The mining department of the Salt Lake Tribune of the 21st carried a story to the effect that there was a l
of the Giroux and Ely Mines c
properties being merged with th
Consolidated and made an a
holding of the Utah Copper C
that the scheme was to issue m
Copper shares and trade them
oux and Ely Mines stock. In t
it was declared, the present mos
relations between the Cole-Rya
and Utah Copper would be mo
cemented. Not being endowed
gift of revelation to the extent t
Utah editors appear to be, we
able to either affirm or deny
est attempt to slip immaculate g
to the shoulders of the Utah
crowd; but, we shall be curiou
how things look when the C
Amalgamated household of rea
miners assent to the handling
thing now controlled by them
grotesquely loud fashion that
much distinction and grace to
lequin movements of Utah Cop
Chino, Butte and Superior and
Goldmines at the present time

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COLLEGE MEN UNDERG

As economic underground o
continue to involve more and n
principles of scientific managem
question of what class of men
fitted to direct these operation
to become more and more in
says Theodore V. K. Smith,
"Captain" of Mineville, New Yo
letter to Engineering & Mining
At most of the larger mines the
gible for the more important p
are, in general, of two classe
timers" or practical men and
lege men with a good educat
more or less practical experie
former naturally far outnumbe
latter. Between these two c
choice must inevitably be made,
larger mining companies at leas
which shall fill these before-m
more authoritative positions.

It is frequently said by colle
after having underground experie
they "learned more about mining
first year out of college than t
in all their four years in colleg
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that most college men will admi
it is probably the training they
during their college years tha
them to learn faster and bette
later they actually "got their nos
muck." Any reasonable man w
admit that a college course, if t
riously, trains any man to be
atic, and in up-to-date mining th
course, a fundamental principle,
ter what position a man may occ
"old timer" may be systematic

are very much so) but it takes
ger to learn than it does a col-
n, and if conditions change and
cessary to learn a new system
t new methods, there is hardly
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wo classes as the difference is
. In other words, an "old timer"
a system merely because it is
or him to work by rule of thumb;
ollege man sees the reason for
s, therefore, quicker to see how
ments can be made by a change
m.

e larger mines in the United
where accurate costs of all under-
operations are kept, it is difficult
average "old timer" or practical
understand or realize the im-
e of such terms as: "Cost per
der," "development cost per foot
"tons per man per day," etc. An
anding and realization of the im-
e of such terms and methods of
eping, of course, enable the oper-
nen to know what the different
of work and supplies are cost-
heir different working places, and
nowledge makes it possible for
o make comparisons and to rea-
the source of leaks, making their
ore efficient accordingly. A lack
wledge concerning how these fig-
e arrived at and what they
to means that such a man might
sily overlook an important leak
asteful expense for a long time
he knew what was really the mat-
f course, many companies do not
practice of allowing their operat-
n to know the cost details of their
but it is, however, common prac-
the better managed mines to let
rating men know approximately
ey are doing in this respect and
ern their work accordingly.

attitude which "old timers" take
such methods is well illustrated
mark heard recently from an old
al man who has spent many years
round. "Figuring may be all right
can't put ore in the skip with a
" As has been said, it is, as a
ard for the "old timer" to under-
he truth and importance of fig-
whereas the technical or college
as been trained in that direction
should come natural to him.

llege man can learn much from a
al man and the knowledge he ac-
from such sources and from ex-
e will gradually develop him into
ight be termed a "practical tech-
man" which is indeed the happy
ation of the two. On the other
t is difficult for an "old timer" to
anything from a college man and
therefore, almost impossible for
er to understand more than the
most elementary technicalities. It goes without saying that there are many exceptions to this statement, some of which are noteworthy in many respects; but as a general rule this condition of affairs is believed to be true.

The ability to handle men is largely a temperamental gift and is as likely to be found in the college man as in the practical man. However, one of the secrets of this ability is to know what a fair day's work is, and probably most mining men will agree that this knowledge is to be gained in no other way than from practical experience. A college man who has never been on the business end of a "muck stick" himself or who has never done his trick at the crank of a machine is certainly in no position to dictate how many cars a mucker should muck or how many holes or feet is a good shift's work for a drill runner. There is nothing more ridiculous on the face of the earth or more properly, under it, than a green college man giving orders and laying out work which he has never done himself.

In such cases a college man will probably demand an unreasonable amount of work from one man and lay out something so absurdly easy and simple for another that the first will generally be justly disgusted and not do so well as he otherwise would and the second will, in nine cases out of ten, "throw a bluff" and "taper" most of the shift. In neither case is the man working efficiently. Therefore it is believed that the best thing a recent technical graduate can do, who intends to follow the operating end of mining, is to subject himself to a year of two years good stiff grind as mucker, machine man, timberman and under-boss of some sort provided he has luck enough to get such jobs and sand enough to hold them. Furthermore, a college man who has not done such work cannot be of much use in the underground operating department of any good mining company.

Another point in favor of long practical experience is the sound judgment it gives, which is required in cases of bad ground, the weight of heavy or moving ground on timbers, the drilling and breaking qualities of different formations and many similar details. The "old timer" can be relied upon to be almost correct in his opinions of such things and although some of the questions which come up in such circumstances are really no more than guesses, the "old timer's" guess is far more apt to be right than any college man's.

A practical man with no college education will work, as a rule, for less wages for a longer time than a man who has been technically educated. The college man calculates that his years of training in a scientific school entitle him to better pay than that received by the "old timer" and he will generally consider himself worth more to the company whether he is or not. As a rule, the "old timer" is more faithful to his employers than the average college man is apt to be and is generally more satisfied with his work, for the reason that a college man looks for rapid advancement while the "old timer," as long as he receives fair wages, is satisfied. Most mining men realize and appreciate the fine loyalty and pride which nearly all "old timers" show and feel for the company which employs them and doubtless most of us can call to mind not a few examples of the fine old men who have spent the best years of their lives in the interest and service of their employers and whose faithful efforts have contributed not a little to the success of mining companies, large and small, throughout the mining countries of the world.

The main points in the foregoing paragraphs may be summarized as follows: (1) The ability of college men to learn fast, to be systematic, to reason clearly and to adapt themselves and their work to changing conditions. (2) The ability of college men to calculate and realize the importance of figures. (3) The possibility of a college man's developing himself into a "practical technical man." (4) The lack of ability in a college man to direct work for others which he has never done himself. (5) The better judgment of the "old timer" in details which can be gained only from long experience. (6) The superior faithfulness of the "old timer" to his employers.

In conclusion it may be said that whether a man is a college graduate or not, the fact remains that the ideal operating man for the efficient mining of today is the one who has good sound common sense, good practical experience, and education and brains enough to handle the technical problems which come before him. Such a man may either be a college man who has gained his technical knowledge in some good scientific school and, to learn the other side of it, has had sense enough to humble himself to a period of good stiff underground labor, or, he may be a practical man who has educated himself sufficiently and who, through hard work and study, has developed into the ideal combination. Statistics would probably show that cases of the former kind are more numerous than the latter and, in view of the economic conditions required in underground operations today, it is therefore believed that the college man is destined to be given the preference.

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Peacock copper is the common name of bornite.

Editorial And Other Notes

On election night a lady who had been watching the bulletin returns telephoned to the folks out home that the result was "a landslide for Woodrow Wilson and Joseph F. Smith—Wilson in the country at large and Joseph F. in Utah."

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Readers will miss in this issue Mr. W. L. Austin's serial article on the "Leaching of Copper Ore." In a letter he explains that professional work has so completely commanded his time during the past month that he was unable to finish his November contribution. He expects to complete it in time for the December number.

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Chino is going to $60 or $65 and Butte & Superior to——. Thus runs the tip (private and confidential, of course). Also it is said that Chino's cost of producing copper will be nothing at all and that zinc will sell for 10c. per lb. The gullible may believe what they please and the lambs will continue to be meat for the bulls and bears.—"By the Way" man in Engineering & Mining Journal.

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Cyanide rash may be relieved by applying a mixture of 3 oz. of camphor dissolved in one pint of olive oil, by heating. This complaint is mainly external, that is, the condition of the blood has little to do with it, as perfectly healthy men are troubled, and medicine is not necessary. Another treatment is the application of a fairly strong solution of potassium permanganate, which dries up the rash in quick time.

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There evidently is a broad streak of humor stowed away in the cranium of Mark R. Lamb, manager in South America for the Allis-Chalmers Co., with headquarters at Santiago. He has been evolving a chart the object of which is to enable men in the profession and others to quickly and unerringly determine a "rating" for mining engineers. He gave his snap away by submitting the drawing and "solution key" to the Engineering and Mining Journal, from which Mines and Methods reproduces it. That "many a true word is spoken in jest" finds full exemplification in the story. Read it.

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The war of words over the present copper market is less sanguinary and more amusing than some others, says the "By the Way" man in Engineering & Mining Journal. The Boston News Bureau quotes a prominent producer, who has been underbid on recent business, as saying: "We can hold out until Christmas at 17¾, and I believe that this is the sentiment of all the leading producing interests." The situation has been stated in the following words in the Wall Street Journal: "The guerillas of the copper market, that is to say, the small and second-hand dealers, are offering electrolytic, delivered, 30 days, as low as 17⅝c. a lb., which naturally renders the 17¾c. peg price of the large interests a nominal quotation"; to which the Journal of Commerce adds in reply the question: "What about the highwaymen who hold up consumers for the benefit of copper-security speculators?"

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The late Malcomb L. McDonald, who will be remembered as a most prominent figure among engineers during the Goldfield boom days, once remarked, while in Salt Lake, that the most profitable investment that he had made while interesting capital in the Nevada camps, was in the purchase of a big automobile. He declared it had a greater influence in parting investors from their money than had anything which the camps had to offer in the way of a mineral showing. Wonder if the same idea is not paramount in the minds of "mining magnate engineers" of these days who blow themselves for private cars and steam yatchs "for business and pleasure purposes?"

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In this number is the first of a series of articles by Al. H. Martin, of Redding, California, descriptive of the methods and practices employed in gold gravel mining. In this first article a brief but comprehensive outline of the devices and schemes employed from the earliest days to recover gold from placer sands and gravels by "dry washing" is given. All branches of the industry, including hydraulic, elevator, pump-dredge and other methods of winning gold not mined in the regular way from veins and deep deposits, will be covered in the articles to come and, as Mr. Martin writes to entertain as well as instruct, his contributions on the subject will be read alike with equal interest by the engineer, operator, investor, miner and layman.

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A good deal has been recently heard about "holes in the air" in connection with sudden collapses of flying machines. Prof. W. J. Humphreys of the Washington Weather Bureau, classifies the eight different types of atmospheric disturbances as follows: A vertical group, including aerial fountains, aerial cataracts, aerial cascades, and aerial breakers, and a horizontal group, including wind layers, wind billows, and aerial torrents; in addition, wind eddies fall under both groups. Holes in the sense of vacuous regions do not exist.

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The Herald-Republican of the 21st quotes "a Salt Lake engineer" who had just returned from a trip to Bingham, in part as follows: "Judging from my personal observations and what I could learn, I believe the Utah Copper company is in better shape than any of the other properties in the district affected by the recent strike. It appears to be employing fully if not more than half its usual force, and the production must be considerably better than half its regular output, which was 18,000 to 20,000 tons daily. A dozen or more of the twenty big steam shovels are busy, and a large tonnage is being sent to the Magna mill. There the vast capacity for ore easily takes care of the half ration it is receiving. Where in normal times you could see twenty-five to fifty loaded cars standing in the yards, yesterday I didn't see one. * * * But to tell you the truth, the way men have left Bingham by the hundreds, and the greatly reduced outputs of the various mines and the difficulty to get laborers, the camp really has a gone-to-hell appearance."

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The commonest form of occurence of molybdenum is in the form of the sulphide, molybdenite, which resembles graphite very strongly. It may be distinguished from it, however, by its weight and by the fact that on glazed paper or porcelain it gives an olive-green streak, while graphite shows black. Moistened with sulphuric acid and heated vigorously, and then allowed to cool, molybdenite gives a beautiful blue color when one blows gently upon it with the breath.

* * * *

Oil for use in a blow-pipe lamp should be rich in carbon. Refined rapeseed oil is used for the purpose, as is olive oil, lard oil, and mixtures of turpentine and alcohol. The disadvantage of these is that they are not always easy to obtain and are objectionable in case the oil is spilled. For this reason, an ordinary small alcohol lamp is commonly employed, but it is impossible to secure a reducing flame, but the ordinary 'short six' is too small to give a large enough flame. In some places large candles of about 2 in. diam. can be procured or, with an empty condensed-milk can to serve as a mold, and employing the smallest size of flat lamp-wick, they can be made with very little trouble by remelting ordinary candles.

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Scale in boilers one-sixteenth of an inch thick means a loss of 25% in efficiency.

EXTRACTING GOLD FROM GRAVEL DEPOSITS

By AL. H. MARTIN.

Man's first gold came from surface placers. Centuries before any attempt was made to win auriferous values from lode veins, the banks and bars of rivers and tributary streams yielded their treasures to armies of searching slaves. Labor was a secondary consideration in those days; the strong arm reached out and gathered workers at its will and practically whole nations were enslaved and set at work in the mines and fields. The fabulous wealth of Ophir and other wonderfully rich districts were derived from the bountiful deposits of gravel that invited where the wandering water courses had deposited their golden memoirs. That many of these placers yielded enormous wealth is evidenced by the plentitude of gold displayed by the leading nations and private individuals. In some states gold became so common that the less easily-obtained silver was the ruling metal. Historical records of the wealth of ancient Greek and Roman families proves many of these private treasuries compared favorably with the great private fortunes of modern times. All of these authentical facts combine to prove that gold must have been produced in immense quantities from the surface deposits of ancient Africa and Asia.

The presence of water for washing gravel and aiding in detection of the elusive gold particles, has always been recognized as a highly desirable factor. But it has often developed that some of the richest gravel occurs in districts remote from the appreciated element. Consequently, air has often taken the place of water, with the blast coming from the strong lungs of the worker in numerous instances. At times the uncertain wind has been impressed to aid in the work. In some of the provinces of China and other Asiatic regions the primitive practice still exists. The gravel is brought on the backs of the workers to a selected spot. Women are generally the beasts of burden, and the material is loaded into bags for the short trips to treating point. The gravel, dumped in conical heaps, is sifted by a man and woman tossing handfuls of the material to the top, which enables the wind to blow away the fine sand while the coarser sand and gravel gradually works to the bottom of the heap. The coarser pebbles are brushed away from the heap and the whole mass gradually reduced to coarse sand and fine pebbles. The miner gathers this in a wooden bowl and holding it high above his head pours the material slowly onto a cloth stretched on the ground. The sand and other particles are naturally blown off by the wind, or should the kindness of heaven fail, the worker emits mighty blasts from practiced lungs. With air-blasts from his lungs the miner blows away the sand and pebbles from the cloth, starting on the edges and working slowly inward. His co-workers, men and women and children, gather around the cloth, and lying on their stomachs watch with eagle eyes for the yellow glint that betrays the gold particle. Each flake of the precious metal is promptly detected, and great is the rejoicing if a few particles of yellow are the reward for a day's work. The plentitude of labor in central Asia permits the working of gravel containing minute traces of gold, that would be absolutely unworkable in other climes. For centuries this crude method has prevailed, and the result has been the development of the Chinese miner into the greatest gravel worker of the world.

ELEMENTARY AMERICAN PRACTICE.

In elementary American practice, the batea, or wooden pan, was extensively used in dry-washing. By means of skillful agitation with the pan, the mass of gravel is gradually worked toward the centre, while the miner blows away the lighter particles. By clever manipulation of the pan and force of air-blasts the waste material is gradually separated from the gold particles, and the latter easily recovered. This method is one of the oldest in existence, and at times has been employed with excellent results, but, of course, is obsolete in this progressive age.

The first great step toward the modern dry-washing machine was introduced in Mexico in 1850, as near as historians have been able to determine. Hungarian miners are credited with the device, which consists principally of a tray, cross-riffles, and canvas bellows. The tray is usually three feet long by eighteen inches wide, with a muslin bottom. The riffles, generally numbering five, are mounted on a frame with an approximate inclination of 15 deg. Beneath this frame the bellows are placed. The gravel is fed into a hopper commanding the tray and moves slowly down the riffles. The bellows drives an intermittent blast of air through the muslin bottom of tray, and the lighter material is forced over the sides and swept away. The gravel flowing down the incline deposits the heavy gravity gold behind the riffles, while the coarse material and fine sand passes over the riffles and out of the machine by the lower section. The slope of the machine may be varied at will by slipping blocks under the rear legs, and when conditions justify, an inclination of 20 to 25 deg. is maintained. The bellows is operated by a wheel turned by one of the miners, and the force of the blast regulated to handle the material to best advantage. The concentrates deposited in the tray are transferred to a batea, where the gold is further cleaned and recovered.

In recent years the size of tray and power of machine have been largely increased, and many of the devices now employed have trays with dimensions of 30 by 60 inches. Two men are employed in operating such a machine, one working the wheel and regulating the air-blast, the other feeding gravel into the hopper and watching the riffles to see the machine is not loaded beyond a safe capacity. Before the gravel is fed into the hopper it is spread out in the sun to dry, and boulders and rocks removed by hand.

In the sunny regions of Mexico, Arizona, southern California and similar sections this practice is easily effective. The machine is undoubtedly efficient in the hands of skilful workmen, but some fine gold is lost with the wasted sands. However, the loss from this source is stated to be small, and the machine is employed more extensively than any dry-washing contrivance on the market. The small cost, and the simplicity of operation, are pronouned factors in its favor.

VARIOUS TYPES OF MACHINES.

The Steele-Sutton-Steele air-jig closely resembles the Hungarian dry washer, with the exception that the stationary tray is displaced by a revolving table or belt, three feet in diameter. This has a muslin screen and riffles about eight

inches apart. As the intermittent blast from the bellows drives the fine sand over top of table, the belt raises the concentrates to the edge of the machine and deposits it in a gold-saving box at the rear. It is stated that this type of machine has demonstrated its ability to recover an extremely high percentage of values in the Sonora, Mexico, fields, but has a tendency to get out of adjustment, forcing frequent stops for a realignment of working parts.

The next important advance in the dry-washer was the substitution of a fan for the long-used bellows. This permits the employment of a constant blast of air, and increases the working capacity of the machine. Most of the latest type of dry-washers manufactured employ the fan, and results are stated to be satisfactory. In some of the machines lately devised, wire gauze and perforated screens are used in the place of the old muslin bottoms. The muslin naturally wears out rapidly, and the use of metal screens materially prolongs the life of this portion of the contrivance.

In the Curtis machine, the tray is in the form of a trough covered with plate nearly an inch thick. This plate is pierced with semi-circular apertures, arranged in cross-sections. Each perforation has an approximate diameter of an inch, and are partly closed by a strip of wire gauze located beneath. This permits the free circulation of the blast from the fan through the material, but effectively prevents the loss of concentrates. The machine is given a laternal agitation by a cam, and the gold settles into the apertures, which takes the place of the ordinary riffle. The Jardine type changes the blast of the fan from constant to intermittent by employing a rotary valve, on the principle that an intermittent blast permits the gold to settle more readily than a constant current of air. In other types of machines, the washer closely resembles the concentrators employed in quartz mills, with fans delivering air for the agitation of materials.

The Lansdale machine, is a combination concentrator and amalgamator, embodying some new principles of interest. In place of the old-time tray of the Hungarian dry-washing machine, is a shaking pan formed like an inverted cone, with a shallow well in the centre, and surmounted by a revolving disc, which forms ths cover of pan. On the underside of this disc are attached several concentrator prongs so arranged that in operation the coarse gravel is expelled from the pan, while the finer portion is retained and agitated until the gold settles into bottom of pan. The shaking motion of the pan carries the gold to the central well where it is caught by mercury previously deposited. The gravel is admitted to the pan through a conical hopper, fed either by hand or a mechanical elevator. A recessed ring containing metal balls is placed around the edge of the pan, and on this the disc revolves. Between the outer edge of pan and the ring is a space about an inch wide through which the tailings are discharged into a funnel-shaped hopper, which carries the waste away from the machine. It is claimed that all fine gold is recovered by this device, and the amalgam can be either retorted in the usual manner, or strained through chamois leather, depending on the condition of the gold. This machine is rather a concentrator than a dry-washer in design, but is said to be most efficient wherever tested. It is a radical departure from the original dry-washer, but retains some of the old-time principles. Mechanical means, instead of the air-blast, are depended on for separation of waste gravel from the gold-bearing material.

The various types of machines herein described, illustrate the numerous attempts made to devise a satisfactory method for the recovery of gold from dry placers, and inventors are constantly endeavoring to augment the efficiency of the numerous contrivances. Hundreds of varying devices have been fabricated, but few have justified their right to endure. The original Hungarian machine still claims the greatest following, its remarkable simplicity causing it to be favored over many later devices of unquestioned merit. Still, numerous machines of recent design are employed in California, Nevada, Arizona and some of the Mexican fields in preference to the more ancient type.

PROBLEMS TO BE MET.

The successful treatment of gravel by the dry-washing process is largely dependent on natural conditions. There are many factors to be considered by the engineer, and the machine is naturally forced to meet several circumstances of prime importance. Some deposits are practically impossible to mine successfully by the dry-washing method, while others present difficulties of an exceedingly complex character. The concentrator must be a machine of fair capacity, low working cost, and able to handle fine and coarse material. When the gravel is cemented, the material must first be crushed to free the gold-bearing material from barren rock, and to release the gold values.

This problem has been effectively solved by the Queener machine, familiar to most gravel miners of northern Mexico and southwestern America. The device consists of a steel trommel fitted with a shaft revolving independently and commanding a number of chain hammers. The hammers easily crush the cemented material which escapes to the gold-saving apparatus through quarter inch spaces between the steel staves of the trommel. The pebbles and cobbles are forced to the end of trommel and discharged. This machine has come into general use in the dry placer fields where cemented material occurs, and has proven remarkably effective. The crushed material is subsequently treated on dry washers and the gold readily recovered by usual means. Credit for the device is claimed by Joseph Lusignan and Mitts Queener, but the latter exploited the machine commercially and is generally considered the inventor. I's use has enabled operators to mine deposits previously considered too refractory for consideration, and has given an emphatic impetus to gravel mining in the arid districts of the great southwest.

It is imparative that gravel be dry. The average material as it comes from the mines is too moist for dry washing, and while the sun is an efficient ally of the gold miner in these sunny regions, it has been found best to dry the gravel by mechanical means. The small operator spreads the moist gravel in the sunshine to dry it, but this is impracticable when a large tonage is treated. The pulverizing of cemented gravel generates sufficient heat to largely remove any moisture prevailing, and cemented material naturally contains less water than the more porus uncemented material. The size and mesh of screens is regulated by the gold, coarse gold requiring larger mesh than that of finer structure. These are some of the questions to be solved by the engineer when arranging for installation of dry-washing devices.

FEATURES OF COLORADO RIVER WORK.

An interesting illustration of dry-washing methods is presented by some of the companies operating in Arizona, near the Colorado river, and a brief description of the process employed may be instructive and entertaining, as the methods have been fashioned along the lines of latest practical developments. In some portions of this deposit the gravel has been penetrated to depths of twenty and thirty feet to the cement bedrock, which in places proved richer than the gold-bearing gravel itself. For years mining has been conducted along restricted lines, the workers frequently packing the richer material from claims to points along the river where water was obtainable for washing. But the great proportion of the deposit could not be thus treated, and dry-washing was eventually recognized as the only practicable means for extraction of the gold. Several small machines of the Hungarian type have been tried at

various points, with pleasing results. About a year ago eastern capitalists became interested in the field, and the Yuma Consolidated Company and other corporations commenced work along progressive lines.

The gravel is gathered up by a Barnett dredger, mounted on a movable platform, with the arm and shovel collecting material in its circular swing. About three cubic yards are gathered at every revolution. The shovel dscharges onto a conveyor commanding a grizzly. The grizzly bars throw off the boulders and large stones, while the finer material drops into a Queener pulverizing machine. From this the disintegrated material is delivered to a Stebbins concentrator. This machine is composed of a table and riffles of sheet metal, and in general form and action bears a striking resemblance to a Wilfley table. The metal table is perforated with exceedingly minute slits, having quarter-inch lengths. A fan drives a constant blast of air through these apertures and the slits, so arranged as to give the air-jet an approximate inclination of 10 degrees above surface of table, causes the air-wave to move down the sloping surface with the gravel. It is claimed that material as coarse as half-inch is easily concentrated on this machine. As 95 per cent of the gold is saved by this simple process, there is no necessity of clean-ups. The black sand, platinum and other metals are separated from the waste product by the concentrator and saved, while the barren rock is received by a conveyor and delivered to the tailings ground. A 130-horse-power distillate engine furnishes power for the entire equipment. The plant has a capacity of 2,000 cubic yards of gravel per day of 24 hours. The placers are situated four miles from Quartzite, and approximately seventeen miles from the town of Ehrenburg, on the Colorado river. In many respects this plant is one of the most complete and efficient ever installed in the dry placer fields of the southwest, and results are understood to be most encouraging. It is stated that comprehensive sampling of the deposits gives average values of over 60 cents per cubic yard.

As in other forms of mining, the larger the amount of gravel, the greater is the profit per cubic yard. For this reason, a large machine can operate profitably in a district where the small washer would only yield mediocre results, all things being equal. When the extent of deposit is extremely limited, the installation of comprehensive equipment, of necessity, is often precluded. In most instances operating costs are light, and only a small crew of workmen are required to keep even the largest plants in constant commission.

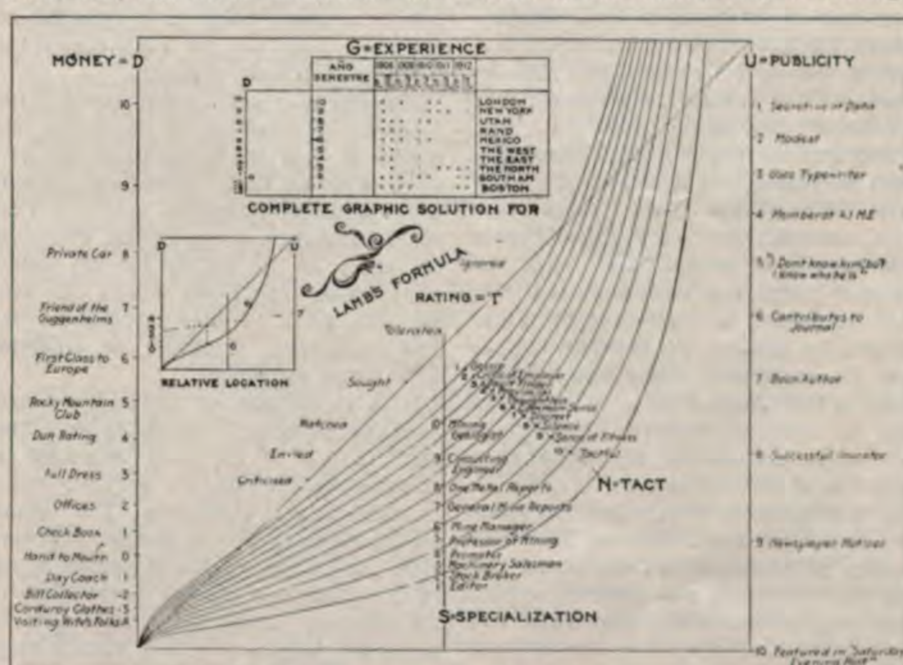
WHO IS A MINING ENGINEER

By MARK R. LAMB.*

This question has been discussed exhaustively, but heretofore only as an ethical problem. I have discovered that it may be solved practically to two-decimal accuracy by the use of an easily understood diagram. Right now, before going further, it is insisted that to be entitled to consideration, any criticism of this solution or of factors or their values must be accompanied by a sworn statement that the critic has not yet determined his own Relative Location.

THE FACTORS NEEDED FOR SOLUTION.

The purpose of the chart is to furnish a rapid solution, sufficiently accurate to be well within the limits of the observed data. The chart consists essentially of three parallel scales, one for Publicity, U; one for degree of Specialization or diffusion of efforts, S; one for Money value, D; a diagonal line graduated in Professional Associates Rating, T; and a set of curves for the various values of N, or the coefficient of friction, sometimes improperly called "luck" curves. This Tact factor N, while of course the most important, unfortunately must be assumed. It has been found best to obtain disinterested opinions from various sources and either average or integrate them.



Graphic Solution Chart for Lamb's Formula.

Corresponding values for Money and for Publicity lie in a straight line through a point on the Rating diagonal where this is cut by a vertical through the intersection of the Specialization and Tact lines determined by the given conditions.

A good client of mine will serve as the subject for an example. The diagram has been so arranged that, given the necessary data, the relative location of a mining engineer can be determined in ten seconds. To make the method clear, however, it will be described in some detail. My good buyer came to Chile to examine a copper mine, bought it, promoted it, equipped it and is now manager. Plainly therefore, his value on the Specialization scale is 6. As the word "native" frequently is on his lips, his Tact factor can never by any chance be greater than 5.

Project horizontally from 6 of the Specialization scale to Tact curve 5 and thence vertically to the rating diagonal. A straight-edge connecting this point with 7 on the Publicity scale (he contributes to the Journal and is writing a book on "The Aborigines as Miners") gives him a rating of 2.5 on the money scale. This is only fair and handicaps him in the final test.

His geographical position during the sumed with any degree of confidence in its accuracy. Indeed, this is very variable and can vary with the climate, the dinner or the baby's health.

Space forbids enlarging upon this important factor. Each would-be mining engineer can look back over his life and locate definite periods when his value for Tact was very low and changeable. Usually—though not always—he can notice a gradual increase in value.

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last five years, by semesters, was as follows: Beginning with the first semester of 1908, his record on the "G" table appears as a broken line through the points 2, 2, 4, 8, 9, 2, 2, and 2, making an average of 4.5 from which project to the small Money scale. The point of intersection on the Relative Position scale gives his standing as a mining engineer. It will be seen that his relative position is secure at 4, but how much better it would be with at least some experience in London—or with a high Tact value.

He is an example of man whose actual earnings would entitle him to a higher position on the Money scale, except that such earnings are not as a Mining Engineer, but rather as a commercial reward.

BABY'S COLIC AS AFFECTING RELATIVE LOCATION.

Each engineer, in determining his own location, will find that some years of study and self-examination are necessary before a value for Tact can be as-

The word-values opposite the numbers on each scale are intended only as an aid to the unimaginative. Conceivably they may be changed or inter-changed, though this should be done with extreme caution. Even before this has gone to press, a noted engineer has insisted that "full-dress" and "check book" on the Money scale should be interchanged. He gives no reason, but it is perfectly plain that such a change would raise his relative position. Another engineer insists that he would travel "first class to Europe" under any circumstances. He declines to give us his factors for working out his position, but it seems certain that his experience points would be all close to the "Boston" line. Word-values may be interlined between those given on the various scales, depending upon the ideas of the engineer.

It will be noted that while the value of Money influences and in fact will usually predominate in determining the relative location of the engineer, experience and consequently knowledge has progress is stopped quicker and oftener by a low value of the coefficient of Tact than by technical shortcomings.

PUBLICITY BY TECHNICAL CONTRIBUTIONS.

Values for Specialization and Publicity can be determined easily. The first is not easily changed and depends more upon outside influences than any of the others. Publicity can be changed only by the expenditure of effort continuously, though it can be gained out of office hours, on the train, during holidays and Sunday mornings by a judicious and continuous recording of experience for the technical press.

The chart furnishes a means of determining any one of the four factors, the other three being known. This will be very useful when it is desired to find the Tact coefficient of a man, for example, who is to be employed by a stupid board of directors or in a country where the feeling against his nation is strong. The determination of this factor from testimonials or even from preliminary interviews is misleading. This is because, however variable its value, Tact is always under the absolute control of the engineer whenever he sees fit to exercise control. His prospective employer wishes to know its average value.

The range of values on the several scales covers all but the most extraordinary conditions. The graduations on the Money scale range from "private car" to "visiting wife's folks." This will include 99.9 per cent. of the readers of the Journal.

The Specialization scale provides for any possible condition, as is proven by the terms describing the two extremes. It is perhaps well to forestall possible impulsive and unthoughtout criticism of this scale by explaining that while a diversified or dispersed experience increases a man's value as a manager or editor, it does not per se increase his value as a mining engineer.

The Publicity scale ranges from utter obscurity as described by the words "secretive of data" to "featured in the Saturday Evening Post." These are certainly the limits of terrestrial publicity. Two years have been spent by the writer in the study of the values for the Publicity scale. Therefore, though this factor may seem to have been given undue importance, it should be accepted with entire confidence.

It is understood, of course, that only desirable publicity is available as a factor. In one of the early attempts to arrange the diagram, the publicity scale included minus quantities. The minus portion of this scale is useless, however, since no degree of Specialization could raise an engineer's value above zero, if his Publicity rating were below zero. It is hardly necessary to say that a high value for Tact is incompatible with a low Publicity.

There is no royal road to desirable publicity. Neither can it be purchased. An engineer I know has a standing offer with the editors to buy all the desirable publicity they can furnish. He also has a reward standing for a practical, effective scheme for professional advertising. There is another point to be taken into consideration in choosing a value for the Publicity factor. An engineer may today enjoy a high degree of desirable publicity and tomorrow, through having detached more than his dentist has equipped him for, suffer with an equally large factor of publicity of opposite sign. The desired value in such case is obtained simply by adding the plus and minus quantities.

TACT THE IMPORTANT FACTOR.

The Tact curves cover all the values obtainable from such noted authorities as Socrates, Marcus Aurelius, Aesop, Solomon, Lord Chesterfield, Uncle Remus and Uncle Charley. The coefficient for Tact is, of course, the most influential. Except for the effect of the title of this article upon the value of my own Publicity factor, it would have been called the solution of the Tact formula.

The Money scale, or the man's monetary values as a mining engineer (upon which the results are usually sought) with reasonable care in reading will give results to within two or three units in the second significant figure, an accuracy well within that of the original data. With Specialization and Publicity factors unvarying, an engineer will find his Money value shift frequently from "full dress" to "check book." "Office" is the critical point with many engineers. It is a point reached several times before it is passed permanently. This fluctuation is caused by variations in the value for Tact.

The study upon which this solution is based has been laborious, extending over many years and involving the painstaking accumulation and correlation of data. It is based upon strictly scientific and accepted theorems and I trust that my own life line will not be thougnt to have inffuenced the final diagram.

WHAT NOT TO SAY AND WHEN.

Many lessons can be gathered from a few searching and candid analyses of the qualifications of one's friends. For example, if my client above mentioned had a pubicity rating of only 4 or 3 his Money value would be very low. Even with a protracted London experience, he could not attain a good relative location as a mining engineer. To be sure, he could raise his Tact factor, but he will not—he is too old. A man entitled to Tact curve 7 or 8 will rarely find use for the words 'Englishman," "American" or "native" in ordinary conversation. If he must know your nationality he will say, "What is your native city?" rather than "Do you speak English?"

Much (Allis-Chalmers Co's.) time has beent spent in preparing this. If it has been the means of calling your attention to the low average value of your Tact coefficient, your employer's sighs of relief will amply reward me. In order to obtain the best results from the use of the diagram it should be used frequently and should be kept handy. This advice is particularly for the younger men. They can learn and change, whereas the old men are bunkered.

FIRES IN METAL MINES; REMEDIAL SUGGESTIONS

By GEORGE J. YOUNG.*

The recurrence of mine fires in Nevada during the past decade is not only a matter of interest, but also one of considerable concern to engineers and mine managers. The more important fires may be enumerated as follows:

Forman Shaft fire, Gold Hill, April 21, 1903; shaft house, machinery, and shaft destroyed; loss estimated at $50,000; cause unknown.

Union Shaft fire, Virginia City, July 14, 1904; shaft house, machinery, and shaft in part destroyed; loss estimated at $100 000; cause of fire stated as the careless throwing of a match in the rope-house.

Sutro Tunnel fire, Virginia City, Jan. 27, 1909; 700 feet of tunnel-timbering destroyed, and direct damage of $10,000; cause "probably electric wires."

Belcher Shaft fire, Gold Hill, August 9, 1910; shaft-house destroyed, machinery ruined, and upper part of shaft damaged; damage, $25,000; no cause given.

Belmont Mine fire, Kimberly, August 23, 1911; fire originated in shaft-station from unknown cause; 7 men killed, and $34,521 damaged caused.

(Note 1.—On June 11, 1912, some time after the present paper was written, a fire broke out in the pump-room on the 2475 station of the Ward shaft, Virginia City. This fire was caused by the short-circuiting and exploding of the starting switch on No. 5 pump. The oil in the switch was scattered about and set fire to the timbers and lagging of the pump room. The pump man in charge notified the surface, and the electric current was shut off. A hose was then turned on the fire but the dense smoke drove the attendant out. Inspection by the electrician and the shaft foreman, equipped with oxygen helmets, soon after, showed no flames or excessive heat, but the continued expulsion of smoke indicated that some fire was present. The pump chamber was then ordered flooded. No estimate of the damage was published and no fatalities occurred.)

It is not the purpose of the present paper to discuss the above examples, but rather to use certain features of them to formulate general plans which might be of use in fire prevention and fire fighting.

*Professor of Mining and Metallurgy, Mackay School of Mines, Reno, Nevada, in Trans. Am. In. of Mining Engineers, October, 1912.

In the above list fires are noteworthy in that they originated in wooden shaft houses and communicated with workings underground, resulting in considerable damage. The risk taken by closing in the mouth of a shaft with wooden buildings has long been recognized, and most of the western mines have eliminated the shaft house. In Virginia City, on account of the severe winters, the shaft house has been retained, but, following the lesson given by these three fires, and the passage of a mining regulation governing this feature of mine construction, active steps have been taken to remove the risk. In almost every case where the shaft is used as a working shaft wooden buildings about the shaft mouth have been removed.

Mine fires may be considered in two groups: those which occur in the surface plant and those which occur in the underground workings. Fires in mine surface plants do not, as a rule, result in loss of life, and if proper fire fighting facilities are provided, the fire may be extinguished with but moderate loss. In Nevada considerable progress in the use of fire proof construction has taken place in recent years. The following steel and semi-fire-proof constructions may be noted: Goldfield Consolidated mill, Goldfield; New Belmont mill, Tonopah; Nevada Consolidated concentrating mill, McGill; Nevada Reduction Works mill, Dayton; Nevada Hills mill, Fairview; Pittsburgh Silver Peak, Blair.

Steel head-frames: Montana Tonopah, Tonopah; Tonopah of Nevada, Tonopah; Union shaft, Virginia City; Star Pointer shaft, Ely; Merger mines shaft, Goldfield; Giroux mine, Kimberly.

The protection of the surface plant from fire is recognized as a necessity, and most mining companies, where an extensive plant has been installed, provide facilities of some sort for fire fighting. In the design of a surface plant the question of fire risk should receive considerable attention. The segregation of different parts of the plant, the separation of each unit by a sufficient distance to prevent the spread of a fire from one unit to another, and, finally, the use of materials which are either fire proof or of a slow burning nature, are the main points which deserve consideration at the start. While it is true that the use of expensive materials and equipment is not warranted in the early stage of a mine's development, it is often the case that after a mine has reached the producing stage the same types and materials of construction are used, and a surface plant grows until it involves an amount of combustible material that in itself is a risk of some magnitude. The inevitable happens, a fire gets beyond control, and the destruction of the plant follows; this occurs in spite of what were deemed adequate fire fighting facilities.

That a more general use of fire proof and semi-fire proof materials and construction in western mines is merited goes without saying. That there is progress in this direction no one familiar with the more recent camps of the west can deny. It may not be out of place here to review the different types of building construction used for surface plants. They may be enumerated:

1. Timber frame with board siding.
2. Timber frame with corrugated iron siding and roof.
3. Steel frame with curtain wall construction in which brick, ferroinclave, and cement plaster or reinforced concrete is used.
4. Reinforced concrete.
5. Brick walls, steel frame, and corrugated iron roofing.

In Nevada the first two methods of construction are common in the case of the most mines and prospects. Of these, the second method is preferable on account of reducing the amount of combustible material. By whitewashing the timber work both ignition and the spread of a fire may be retarted. The third method of construction is in use where large plants, more or less permanent in their nature, are erected. Examples have been cited above. The fourth method is quite common in coal mine surface plants in Westphalia, Germany, but is not often met with in the Western States of America. It merits consideration by the mining engineers of the United States. The use of reinforced concrete in uncommon, but some examples are to be recorded in Nevada. The Midway mill, erected in the early days of Tonopah, was constructed with steel frame and corrugated iron siding, and contained a reinforced concrete ore bin. In the Belmont mill and the Goldfied Consolidated mill, reinforced con-

crete has been used. In Nevada, brick construction, for obvious reasons, is not used for mine plants, but in the case of electrical installations for power plant and sub-stations this method of construction is common.

The critical parts of a mine surface plant are: the blacksmith shop, boiler and power plant, change quarters, wood shop, oil-storage, rope house, and the structures about the shaft mouth. With order, cleanliness. and a proper segregation of buildings, there is little chance for a fire, and yet carelessness on the part of any individual may be the cause of starting a fire, and consequently protection must be afforded by fire plugs and hose reels attached to the water system. Usually the mine plant is compactly arranged, and several plugs and hose reels may serve all purposes. Small fire extinguishers in each building are also considered necessary.

Underground mine fires are serious, as in almost every case there is danger that fatalities may result, and the difficulty and danger of fighting such fires is great. In heavily timbered mines where there is little or no water, the possibility of a small fire spreading throughout a mine is always present. Fortunately, dry mines usually do not have large areas of heavy ground, and heavily timbered mines are often wet mines.

CAUSES OF MINE FIRES.

The causes of fires in metalliferous mines are:

The presence of combustible materials, such as timber, oils, waste.

Carlessness with candles, lamps, and smoking.

Blasting; remnants of smoldering fuse.

Overheated bearings in machinery.

Short circuiting and overheating of electric wires.

Spontaneous combustion.

Rapid progress has been made in the development of methods of mining involving a small proportion of timber, as compared with that required by the "square set" system, are in use. Even though we may largely eliminate timbered stopes or, by filling, practically eliminate the fire risk from them, we still have the timbered drifts, stations, shafts, pump stations, and winzes. We could almost completely eliminate the fire risk from these by the use of steel and masonry, but this is practicable only in a few cases, and the mines of the west will undoubtedly utilize timber for many years to come. Underground, a relatively large amount of combustible material must be contended with. The critical places are the shaft mouth, the shaft, the stations, the drifts, and the winzes. The critical condition is where the timber is dry and comparatively little water occurs. Where water is encountered the fire risk is lessened. Systematic elimination of combustible material should be the first thought of the engineer. The proper protection from fire where combustible material must be used is the next consideration.

Carelessness with candles may be eliminated by the introduction of electric lighting, and this method of lighting is common in western mines of any size. Where candles are used, proper receptacles at stations and in stopes should be provided and their use insisted upon. The use of these will go a long way towards eliminating this cause. The setting of lighted candles upon timbers should be prohibited, and the removal of all candles from working places when miners are leaving should be required. Lamps should be sparingly used, and where possible these should be filled and trimmed outside of the mine. Oil, and particularly oil required in illumination, should not be stored in the mine. Where oil lamps are used by the miners, some form of solid illuminant should be used. Smoking can be controlled by mine regulations, and in the heavily timbered mine, or in and about a wooden surface plant, it should be prohibited. Where possible, the development of a stable, steady working crew of men is an important factor in preventing accidents of any kind. Good foremanship is essential to this end.

Blasting as a cause of mine fires is, no doubt, of minor importance. I know of no authentic case where the flame of a blast has been responsible for setting timbers on fire. In the case of the Homestake fire a piece of smoldering fuse has been given as the cause. However this may be, it is necessary to carefully inspect timbered stopes after blasting. A fire originating from any cause during the interim between blasting and the arrival of the next shift may thus be discovered before it has gained any considerable headway.

Overheated bearings of machinery are an infrequent cause of fire. Underground ventilating and pumping machinery are the only forms of machinery which would be likely to cause trouble of this nature. Ring oil bearings on motors and fans have, to a considerable extent, removed this source of danger, but frequent inspection of machinery should be made. Where fans are in use an inspection should be made at least twice a shift by the shift boss. Ring oil bearings should be frequently examined and kept filled, and at intervals the oil should be completely removed, and the bearings thoroughly cleaned. Machinery oil should be kept underground in quantities only sufficient for several shifts' use. Machinery, where possible, should be placed in untimbered chambers or, where support of some kind is necessary, masonry, steel, or some fire proof material should be used. At Virginia City the pumping rooms are heavily timbered and in themselves contain sufficient timber to sustain a considerable fire. The practice is to whitewash these timbers, and to keep such rooms thoroughly clean. While this reduces the fire risk, still the presence of so much combustible material, and some of it of an oil soaked nature, must be considered as a risk, and precautions should be taken to minimize it. (See note 1.) Such chambers can be readily provided with hose plugs and reels. Where machinery of any size is in operation, the presence of attendants is usual, and is an additional safeguard. Oily waste and waste of any kind used in and about underground machinery should have metal containers provided.

Electric wires and apparatus may have been the cause of some fires, but where their installation has been carefuly looked after, and they are in the hands of experienced men, it is seldom that a fire can be directly traced to their use. (See note 1.) The proper making of connections, the use of fuses, and automatic circuit breakers on all apparatus will prevent excessive loads coming upon lines, electric motors, and transformers. At Virginia City transformers are used at several places underground. These are placed in timbered stations, but this practice is open to question. Transformers should be placed in chambers free from timbers, and only material of a fire proof nature should be permitted in the vicinity. In surface electrical work transformers are placed in fire proof buildings, and out of contact with wood work. Where transformers are in use underground, and in the vicinity of combustible material, buckets of sand should be placed where they can be used in extinguishing a fire.*

Spontaneous combustion is an infrequent occurrence, for the reason that underground conditions are seldom of a nature that would lead to this cause. Oily waste might, under extreme conditions, develop sufficient heat to ignite combustible material in its neighborhood, but it is seldom that this is present. Fires in mines containing heavily sulphureted ores are claimed by some writers to be due to the heat produced by great pressure. While this cause is not of great importance, a careful mine manager will not overlook it.

FIRE PREVENTION.

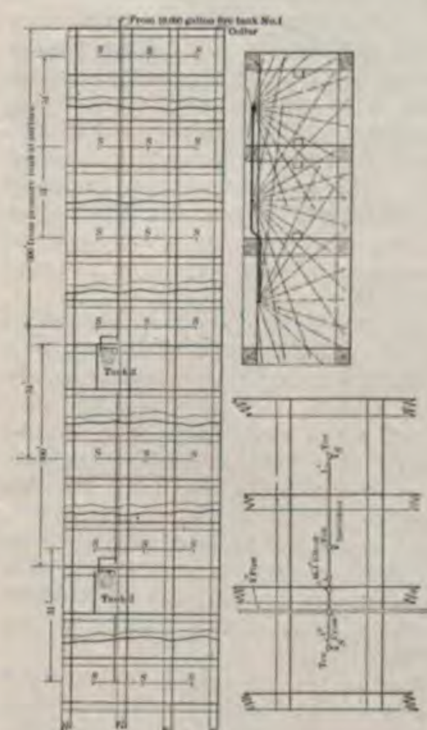
The first line of defense in the prevention of fire is a proper set of mine

*The Factor of Safety in Mine Electrical Installations, Technichal Paper, No. 19, U. S. Bureau of Mines (1912).

regulations covering the use of candles, lamps, oils, and other combustibles used underground; the second is the enforcement of these regulations. Without discipline mine regulations are of little avail. The third line of defense is the practice of a fire drill at frequent intervals. This practice should include drill in the use of fire fighting apparatus, the training of a suitable fire fighting squad, and the accustoming of the men to answer an emergency fire call, so that a possible panic among the men on the alarm of fire may be avoided. The drill should be segregated into the drill of the fire fighting squad at least once a month, and the drill of the whole mine force in answering a fire call at least once in three months. The fourth line of defense is the use of watchmen, whose business it should be to inspect the mine workings after a shift has departed or at frequent intervals when the mine is shut down. These men serve to check up careless miners and prevent a small fire from spreading.

Facilities for fighting incipient fires should be provided, and placed at readily accessible points in the vicinity of the places where there is any considerable amount of combustible material. These places would be at shaft stations, the sill floors of timbered stopes, timbered winzes, and shaft collars. Fire extinguishers of a simple type would be the means provided. Water pipe lines should be laid to large timbered stopes, and hose connections provided. Hose reels should be placed at the critical points. The whole system should be standardized so that hose, couplings, etc., could be transferred, and used in any part of the mine. At the surface a reserve supply of hose should be provided. A monthly inspection of fire fighting appliances should be provided for.

Steel fire doors, or wooden doors protected by tin sheets, set in concrete bulkheads, should be provided in crosscuts and drifts at such points as would enable the spread of a fire starting in a stope to be checked. These would only be used in the event of a considerable fire. Such doors must be constructed so as to admit of opening from either side. In important tunnels of any great length and where timber is used several fire doors might well be placed so as to divide the length into sections. In lieu of fire doors a length of 100 ft. of the tunnel could be supported by masonry instead of timber, and this would localize a fire. In tunnel fires fire-doors cannot always be reached, and the conditions may be such that temporary bulkheads cannot be constructed. In such cases the masonry zone might prevent the fire from spreading through the entire length of the tunnel. In railroad tunnel work, where, from financial conditions, timber must be used instead of masonry, masonry zones might well be used. The recent fire in the Chilcot tunnel of the Western Pacific railroad is a case in point. A main working shaft in a mine would admit of fire localization in the same way. In place of masonry, steel tunnel sets or shaft sets could be used. While perhaps general rules for the placing of fire stops and doors could be formulated, the conditions at each mine would have to be studied and the locations of these safeguards determined in such manner as to best meet those conditions.



Automatic Sprinkler Installation for a Mine Shaft.

O. F. Heizer has informed me that at the Seven Troughs Coalition mine, Seven Troughs, Nev., hinged wooden doors, protected by 3-16-in. steel sheets, are placed at the second set below the collar of the incline shaft (75° incline). These doors are held by tickers controlled by a lever. Slots are cut so that interference with the hoisting cable is avoided. Ten sacks of sand are stored close by the shaft. In the event of a fire on the surface the surface men have instructions to throw the doors and place the sand over them. He informs me that this device worked very well on one occasion when a fire took place in the surface plant. He also informs me that at the Nevada Hills mine, Fairview, two steel sheets are arranged at the mouth of the shaft so that they may be slid over the opening of the compartment by throwing a lever. No special rollers are used, the sheets simply sliding on angle irons.

To one familiar with conditions in western mines, it is a matter of surprise that advantage has not been taken of the automatic sprinkler, which is in use for the protection of warehouses, factories, public buildings, and the like. I know of no instances where this system is used underground, and only in a few instances, notably in Montana, have they been used in metallurgical plants. The system as applied to buildings consists of a net work of pipe-lines supplied by a pressure tank. The pipes are so distributed as to admit of a sprinkler-head being placed in the center of each 10-foot square. The sprinkler-heads are placed close to the ceiling. Each head is provided with an opening which is closed by a non-corrosive button. The button is held in place by a two-piece metal strip. The pieces of the strip are held in place by a soft solder which has a metling point sufficiently low to be speedily reached by any fire in the vicinity. With the melting of the solder the pieces fall apart, the water pressure forces the button out and the water spurts out against a a spreader which throws the water spray over a considerable area. A melting point of 155° F. is used in the well known Grinnell automatic sprinkler. The complete installation of an automatic sprinkler system in a mine, while not necessarily impracticable, would in most cases be unnecessary. As has been mentioned, the critical places are the shafts and shaft stations where the timbers are dry. Shaft and stations might well be protected by such a system. Timbered pump or machinery stations, on account of the value of their contents and their importance to the mine, could also be protected in this way.

The installation of an automatic sprinkler system in a shaft is represented in Fig 1. Two main points in the design of such a system need consideration: one is the question of water pressure; the other is the use of protective coating upon the pipe so that scale and rust cannot form and clog the sprinkler heads. In a deep shaft it is doubtful whether a continuous pipe line could be employed without the use of extra heavy pipe and fittings. By placing pressure tanks at intervals of from 300 to 500 feet; ordinary or "extra strong" pipe and fittings could be used. The intermediate tanks could be supplied from the pipe-line above by means of valves operated by float. The use of galvanized pipe and fittings would eliminate ordinary troubles of corrosion.

In each compartment of the shaft, at intervals, sprinkler heads, point downward, would be placed. In order to be

out of the way these would be placed back against the lagging, but this position would not prevent their effective operation. A three compartment shaft would be protected by making the intervals between sets of sprinklers 50 feet.

The cost of such a system is nominal compared to the amount of damage a shaft fire might cause. I have estimated the cost of pipes, sprinklers, and pressure tanks (every 300 feet) for a shaft 1,000 feet deep to approximate $500, or $0.50 per foot. In Fig. 1 a 2-in. pipe is assumed as sufficient. In the cost of the system should be included a fire tank on the surface. Shaft stations would be protected by extensions of the pipe system along the center line of the station and the spacing of sprinklers every 10 feet.

The advantage of such a system is its automatic operation. A fire arising in an obscure portion of the shaft would be taken care of and extinguished before it could spread. The shaft, the main exit of a mine, could thus be always protected and maintained in a workable condition. The possibility of saving life in the case of a fire would be greatly enhanced if shafts could without question be kept open.

By extending the sprinkler system along each drift for 50 or 100 feet, a fire could be prevented from spreading to the shaft.

An automatic system to be satisfactory should be inspected at frequent intervals and such a system, carefully installed, would not require an overall inspection more than once in three months

A telephone system is an indispensable part of the equipment of a large mine. Not only is it necessary to install telephones at stations, but important winzes and stopes also should be provided with this appliance. The prompt warning of the men may be the means of preventing loss of life. This could be done by telephone or by the use of flash signals where incandescent lamps are used. In Virginia City an "all out of the mine" signal is in use, and the electric lamps by a given number of flashes convey this signal.

Fire fighting helmets are now considered necessary at all large mines, and the training of men in their use should be a part of the fire drill. Oxygen helmets also should be provided for possible use in rescue work as well as for the attack of smoldering fires which would produce such an amount of smoke as to prevent near approach. So well has the subject of the construction and use of the oxygen helmet been discussed that further comment is unnecessary here*

All underground air lines should be provided with connections at stations, winzes, and stopes. These connections should be maintained in working order at all times. In the Belmont fire a connection on the air line at the 1100 station would have been the means of saving life. Where a water pipe line is not in use in a working shaft, connections should be made at the surface, so that the air line could be used for purposes of bringing water to a fire. It is preferable to have two lines of pipe in a shaft, one for water and one for compressed air.

FIGHTING MINE FIRES.

The first essential in fighting a mine fire is to get all of the men out of the mine. When this has been accomplished, a plan of action can be decided upon and carried out under competent direction. The usual steps may be stated as: bulkheading, with the object of localizing the fire; laying of hose and the bringing of a water supply to the scene of the fire.

The fire fighting squad necessarily works upon the incoming air side of a fire unless equipped with smoke or oxygen helmets. By carrying air lines along with hose lines, fire fighting squads have been enabled to approach close enough to a fire from the "lee side" to do effective work. It requires courage and daring on the part of the fire squad to perform work of this kind, but instances are not uncommon where stubborn fights of this kind have been made.

Where it is impossible to approach the fire close enough to fight it with water, two methods may be used: one is the bulk-heading of the fire on both sides and the closing of all winzes leading from the fire zone; the other is to seal the mine and fill the workings with a gas which will prevent combustion. In the former method the fire is left to smother out, and this may take considerable time. The availability of the oxygen helmet renders it possible to construct bulkheads where it would have been practically impossible without the use of this appliance. In fighting a fire by the second method, steam, sulphur dioxide, and carbon dioxide have been proposed as gases suitable for the purpose. Steam is the agent most used. If a supply of sulphur could be speedily obtained, it might be possible to use this reagent in temporary burners arranged so as to discharge the gases into the intake air ways. Snelling has given details of the method. Carbon dioxide is difficult to generate in sufficient quantity, and its use is almost out of the question save as it is generated by the fire itself. Where it is impossible to bulkhead a fire, and steam or other agent is out of the question, the flooding of the mine is the next expedient. If it is impracticable to flood the mine, the turning of water down the shafts after sealing all openings to the mine is then in order.

The greater danger in all mine fires is the rapid filling up of the workings with smoke and poisonous gases (CO). To one who is familiar with fires this is the most striking thing. The comparatively restricted workings of a mine fill up in a very short time on account of the air currents, which, while normally moving sluggishly, under the increased temperature rapidly acquire velocity. The presence of fire doors at intervals may be the means of preventing workings from being completely flooded with irrespirable gases. If it were possible to stop all air currents in a mine by doors suitably placed, the fire and the gas would be prevented from spreading outside of a restricted zone.

As in the case of surface fires, "being prepared" is the key to the situation. Mine superintendents should carefully consider the possibilities of a fire, and make every preparation beforehand, even to laying out a method of proceedure for fires occurring in different parts of the mine. The drafting of a plan of action, the provision of apparatus and means for carrying out this plan, as well as the drilling and training of the men who are to carry the plan into execution, will go a long way towards preventing confusion, delay, and loss of control at the fire signal. The provision for marking the passages leading to shafts and exits hould be carried out in all large mines. A careful study of the ventilating currents in a mine and a consideration of the effect of a fire in changing their direction also form necessary parts of any fire fighting plan. Ventilating plans of the mine under varying conditions should be prepared, and their study made a part of the drill by the fire fighting squad. The effect of turning a stream of water down a shaft upon the air currents deserves mention. In most cases a stream of water turned down an upcast shaft has the the effect of reversing the air current. In the Giroux fire the upcast shaft which was on fire was provided with a water pipe, pierced with holes, close to the collar of the shaft. An attendant at the surface (without authorization) turned the water into this pipe, and thus reversed the direction of the air, causing the shaft to act as a down-cast. The Alpha shaft, which was the down-cast, became an upcast, and the miners escaping by this shaft were killed by the gases.

*The Use and Care of Mine-Rescue Breathing Apparatus, Miners' Circular No. 4, U. S. Bureau of Mines (1911).

LEGAL REGULATIONS.

An examination of the mining laws of the western states indicates no general tendency to comprehensively cover the subject of mine fires. As an example, the regulations provided by the State Mine Inspector Law of Nevada may be cited. These regulations are grouped as follows:

Regulations Relating to Egress From Mines.

"Section 19.—All shafts be equipped with ladders, and shafts more than 200 feet in depth, inclined more than 45 degrees from the horizontal, equipped with hoisting machinery, shall be divided into at least two compartments; one compartment to be divided off and set aside for a ladderway. The ladders shall be sufficiently strong for the purpose demanded, and landings shall be constructed not more than 30 feet apart. said landings to be closely covered, except an opening large enough to permit the passage of a man. A landing shall be constructed in manway at all working levels."

"Section 20.—In every mine within this State, if more than 200 feet in depth, where a single shaft affords the only means of egress to persons employed underground, and the ladderway compartment is covered by a non-fireproof building, it shall be the duty of the operator of said mine to cause said ladderway to be securely bulkheaded, or a trap door placed over same at a point at least 25 feet below the collar of the shaft, and if a trap door is used, it must be kept closed, or so arranged that it can be closed from a point outside of the building by the releasing of a rope, and below this bulkhead or trap door, if the shaft is situated on a side hill, a drift shall be driven to the surface, and if the shaft containing said ladderway may be otherwise situated, this drift shall be driven on the level to a safe distance, but in no case less than 30 feet beyond the walls of the building covering the main shaft, and from such a point a raise shall be made to surface. The said raise shall be equipped with a ladderway, and it, together with the drift connecting with the main shaft, shall be kept in good repair, and shall afford an easy exit in the event of fire."

"Section 21.—Whenever the exit or outlet from a mine is not in adirect or continous course, signboards, plainly marked, showing the direction to be taken, must be placed at each departure from the continuous course."

"Section 28.—It shall be the duty of every operator to provide every tunnel or adit level, the mouth of which is covered by a house or building of any kind, with a door near the mouth of the same, that can be closed from the outside of the building by a pull yire or cable in the event of fire; inside of door a raise shall be run to conect with surface, thus affording a means of exit in the case of fire."

Regulations Relating to Structures over Shaft Mouths.

"Section 27.—It shall be unlawful for the operator of any mine within the State to erect any structure over the shaft of any mine, except head frames necessary for hoisting from said shaft or outlet, and the hatch or door necessary for closing such shaft or outlet; provided, however, it shall be lawful to erect a house of non-inflammable and fireproof material over such shaft or adit to protect the ment working at such point. In the case of existing houses covering months or shafts or adits, it shall be the duty of the superintendent of the mine to cause the immediate removal of all inflammable material stored therein; and it shall be the further duty of such superintendent to prohibit the storage of any inflammable material 30 feet from the exterior walls of any housing hereinafter built."

Regulations relating to Inflammable Materials Used Underground and on Surface.

"Section 16.—All timber removed shall, as soon as practicable, be taken from the mine, and shall not be piled up and permitted to decay underground."

"Section 22.—Use of gasoline underground is forbidden."

Regulations Relating to Fire Fighting and Control of Mine Fires.

"Section 41.—At every mine in this State, employing forty or more men underground, there shall be kept on hand at all times, in good working condition, at least two smoke helmets of a design to be approved by the State Mining Inspector, and which helmets shall at all times be subject to his inspection. For every additional fifty men so employed an additional smoke helmet shall be provided."

The regulations are, at best, only fragmentary, but they indicate an effort to provide certain things that a mine operator must do. Most mine operators are willing to conform to any reasonable regulations, but until a more or less complete code is drawn up and incorporated in our State mining laws, we must expect to find them somewhat backward in taking the initiative, except in those cases where either bitter experience or broad training has stimulated operators to take the subject up in detail.

PROPOSED REGULATIONS.

With the object of inviting discussion, and of giving point to the generalizations in the foregoing, I have written the following regulations. The difficulty of providing for every emergency that may arise in a mine fire, and of meeting the miscellaneous conditions that are present in western metal mines, is apparent, and in preparing these regulations I have endeavored to maintain a conservative rather than an extreme position.

Egress from Mines—For mines deeper than 200 feet, and employing ten or more men underground, operators must observe the following:

1. Two outlets must be maintained in good condition at all times during the operation of the mine.

2. Where two or more shafts are in use, two of such shafts must be provided with ladder ways in separate compartments, and such ladder ways maintained in good condition during the operation of the mine.

3. Where ladder way shafts are inclined at a greater angle than 45°, landings closely boarded, and with openings just sufficient to allow the passage of a man, must be provided at intervals not greater than 30 feet.

4. In mines operated through three or more working shafts, where each shaft is provided with hoisting machinery, a ladder way may be provided in but one shaft.

5. Between levels at least one winze must be provided with a ladder way, and the same maintained in proper condition where the level is in use for extraction of ore, or ventilation.

6. On each level the direction to shafts and winzes, used as exits in cases of emergency, must be clearly indicated by signboards.

Mine Surface Structures—1. None but fireproof buildings are to be permitted over shaft or tunnel mouth.

2. Where shaft mouths are open, wooden head frames and bins may be permitted.

3. Non-fireproof buildings must not be placed nearer than 50 feet to any shaft mouth or tunnel entrance.

4. Mine plant buildings of non-fireproof construction must be separated from each other by a space of not less 30 feet wide.

5. In a mine surface plant where non-fireproof construction is employed, hoisting machinery, boiler plant, blacksmith and machine shop, timber framing shop, change house, and storage of supplies must be placed in separate buildings separated by a fire space not less than 30 feet wide.

Inflammable Materials on Surface and Underground.—1. Where fireproof shaft and tunnel houses are in use, timber or other inflammable material in excess of sufficient for one shift's use must not be stored in such buildings.

2. Timber yard or timber storage sheds must be placed not less than 75 feet from any mine building.

3. Lubricating oils and inflammable fluids must be stored in fireproof buildings separated by a distance of not less than 75 feet from other mine buildings.

4. Metal containers must be provided for the storage of all waste used in wiping and cleaning machinery. They are to be provided for each machinery room in the surface plant, and for each group of machines underground.

5. Lubricating and illuminating oils in excess of a 24-hr. supply must not be stored underground or in surface buildings other than the oil storage building.

6. Gasoline and substances of like nature are not to be used underground.

7. Timber in excess of a 24-hr. supply is not to be stored underground.

8. Powder drifts which are used for the temporary storage and handling of powder underground, must be cleared of all paper, empty boxes and rubbish, at least once each 24 hours.

9. Where timber is framed at one or more points in a mine, these places must be cleared of chips and rubbish, at least once each 24 hours.

Surface and Underground Regulations—1. Where mine surface structures are of non-fireproof construction a sufficient water supply must be provided for fire fighting purposes. One fire plug and hose reel must be placed not less than 25 feet from the shaft mouth, and such other fire plugs placed as, in the judg-

ment of the state mine inspector and mine superintendent, shall be sufficient to quench any ordinary fire.

2. At shaft house, in timber framing building, power plant, change room, and such other parts of the surface plant as the mine inspector may decide, at least two fire extinguishers of an approved type must be placed and maintained in proper working order. They must be placed in a conspicuous and convenient place.

3. Smoking shall be prohibited in non-fireproof surface plants.

4. Where more than a nominal number of lamps using illuminating oils are in use a separate lamp house shall be provided and all filling, cleaning, and trimming done in this building.

5. Where water pipes are not installed in shaft, connections must be provided with the surface water system so that the compressed air pipes may be used to bring water underground in the case of a fire.

6. Connections must be made with air pipes at each station, whether the same is in active use or not. These connections must be such that air can be turned into the station.

7. Where candle illumination is used underground metal sconces must be provided at all timbered stations and stopes and miners required to use same.

8. The placing of lighted candles on timbers without proper protection is prohibited.

9. Smoking is prohibited in timbered mines.

10. At all timbered stations which are in active use and where water supply and hose lines are not provided, at least two fire extinguishers of approved type shall be placed and maintained in working condition.

11. Where electric illumination or power is used underground or in surface plant, line installation and protection must be in accordance with the Electric Code of the National Board of Fire Underwriters.

12. Transformers, where used underground, must be placed in fireproof chambers and, at each bank of transformers, sandboxes must be placed and a supply of sand maintained.

13. In heavily timbered stopes fire inspection must be provided after each shift leaves and before the new shift comes on.

14. Air-tight doors shall be constructed in each level, where practicable, between upcast and downcast shafts. Such doors should be preferably of fire proof construction.

Regulations for Fire Fighting and Control of Mine Fires.—1. The mine foreman, under the direction of the mine superintendent, shall have charge of all fire fighting operations.

2. The mine foreman shall designate certain assistants to constitute a fire fighting squad, and assign duties to such assistant. The name of such assistants shall be posted at shaft mouths as the fire fighting squad.

3. The mine foreman shall conduct a general fire drill at least once each three months and at that time examine, test, and report to the superintendent the condition of all fire fighting apparatus, exits, and ladder ways. This report shall be in writing, and shall receive the signature of the state mine inspector on his next inspection visit after the fire drill.

4. In mines employing 50 men, at least two smoke helmets of an approval type shall be maintained in proper working condition at all times. For each 30 men in addition an additional smoke helmet shall be installed and maintained in working condition. The foreman shall instruct the fire fighting squad in their use.

5. In mines employing 200 or more men underground, at least two oxygen helmets shall be maintained in proper working condition. The foreman shall designate certain men for instruction and practice in the use of such helmets.

5a. In mines employing 200 or more men underground, a "pulmotor" in proper working condition must be provided. The foreman shall instruct the fire-fighting squad in its use.

6. A general signal to indicate a surface fire and one for an underground fire shall be designated.

7. Where practicable, an "all out of the mine" signal shall be designated and used in emergency. This signal must be used only by persons to be designated by the superintendent.

8. Detailed instructions to surface and underground men as to what to do in the case of fire are to be posted at shaft mouth and underground stations.

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WATERS OF THE "GREAT BASIN"

The Great Basin of the United States is designated by geographers as that intermontane country lying between the Rocky Mountains and the Sierra Nevada system, covering portions of Oregon, Idaho, Utah, Nevada, Arizona, and California. It is called the Great Basin, because the rivers which rise in it do not flow to the sea, but for the most part empty into lakes, from which the water is evaporated. Among these lakes the largest is Great Salt Lake, which receives and disposes of the discharge of a number of rivers, the most important being the Bear, the Weber, and the Jordan. Others are Owens lake, which receives the flow from the Owens river basin; Walker lake, into which is discharged the water from the Walker river basin; Carson Sink, including Humboldt lake, into which flow the waters of Carson and Winnemucca rivers, which receive the discharge of Truckee river. All the lakes mentioned are located in Nevada except the Great Salt Lake, which is in Utah, the Owens lake, which is in eastern California. In the Oregon portion of the Great Basin there are such lakes as Malheur, Harney, and Warner. Lake Tahoe, which lies partly in California and partly in Nevada, is a high Sierra lake, which receives the water from the surrounding mountain peaks and discharges it through the Truckee into Pyramid and Winnemucca lakes. There are many other bodies of water in the Great Basin of more or less importance.

Practically all of the country included within the Great Basin is desert, though the aspect of some parts has been changed materially by irrigation. Much of the soil is exceedingly fertile when water is supplied to it, as was long ago demonstrated by the Mormons, who settled in that country and founded a strong and prosperous colony that has since taken a prominent part in the development of the west.

The Great Basin contains two irrigation projects of the government—the Truckee-Carson project, in Nevada, which will ultimately cover 200,000 acres, and the Strawberry Valley project, in Utah. The new municipal water supply for the city of Los Angeles is taken from the Great Basin through a long conduit, the conception and construction of which have been a noteworthy feature in recent engineering development.

Along certain edges of the basin, where it ascends to the mountain crests, like the Wasatch range in Utah and the Sierra in California there are many valuable sources of water power, some of which have been profitably developed.

In a region like the Great Basin, the economic development of which is so entirely dependent on its water resources studies of the flow of streams can not fail to be of the utmost importance. During the last 20 years or more work of this kind has been carried on by the United States Geological Survey, which has recently issued Water-Supply Paper 290, containing results of measurements of stream flow made in this basin during the year 1910. The work was done in all parts of the basin and the report contains records of flow obtained at 98 stations.

Copies of this report may be obtained on application to the Director, U. S. Geological Survey, Washington D. C.

FINK CLAIMS PERFECTION OF SMELTING FURNACE

Everybody in the western mining regions of this country will recall the efforts five or six years ago, of Edward Fink, a bright young metallurgical engineer, to prove to the world that he had evolved a smelting furnace in which he could produce blister copper at one operation; of his having constructed a testing plant at the Boston Consolidated mill and having actually turned out from his furnace bars of blister copper from the barrel-shaped receptacle into which the crude ore was fed. Naturally, mechanical difficulties were encountered, and while encouraging progress in their solution was being made, the inventor's backer became suddenly attacked with a bad case of "cold feet" and the experiments were abandoned. That investor, Edward Fink, did not despair and that he now has perfected a furnace that will mark a new era in ore reduction is told by himself in the following article, taken from a recent issue of the Mining and Scientific World.

The many improvements in the mehods of reducing ores are each year adding to the available ore supply of the world, for many complex ores are being brought within the scope of profitable treatment which heretofore were considered too lean or too complex to admit of economical reduction. Mention need only be made of the magnetic separation processes, the various flotation processes, either with or without the use of oil, the advent of the Bessemer converter in copper smelting practice, as well as the many attempts at introducing the various types of electric furnaces into zinc-smelting practice, to show that the metallurgy of the nonferrous minerals is now keeping pace with the rapid strides of the iron and steel industry.

The light of scientific research has dispelled much of the mystery surrounding metallurgical operations of former generations, and a most rapid progress has resulted. Modern concentration plants have grown to prodigious size, and the furnaces used in reducing these ores and concentrate products have grown in proportion, yet in spite of these great advances in ore-dressing practice there still remains a considerable quantity of ores, which cannot be profitably treated, owing to the character of the minerals contained.

The presence of zinc has always been a detriment to the reduction of most ores, and the recent Government Bulletin No. 47, of the Bureau of Mines, by Charles Parsons, has the following reference to ores of this character:

"Besides these losses in mining and concentration of zinc ores, there are incalculable losses, which, without question, run into many millions of dollars, and undoubtedly exceed the total value of the zinc mined, in slags and waste products from other processes. Zinc has been, and in general still is, considered about the worst impurity to be found in the ores of copper and lead, for it has always given trouble in their metallurgy. Accordingly, the practice has been so to run the charge that the zinc passes off in the slag, and to a certain extent in the flue dust. The economical treatment of some ores has been impossible on account of the high percentages of zinc that they contained, and the consequent difficulty of separating the lead from the copper. Much interest is being aroused in the subject, and there is good reason to hope that careful investigation will in time ocercome this loss, and render available large quantities of ore now worthless. To make even an approximate estimate of the total loss of zinc is impossible, but it certainly exceeds thousands of tons daily."

In the early days of Leadville, the lead smelters imposed a penalty upon the ore whenever zinc was contained, and now that Leadville is again coming into its own—as a producer of zinc, however—the operators are confronted with a penalty whenever any lead is contained in the ore.

Thirty-Ton Fink Furnace Producing Blister Copper Directly from Zinciferous Ores.

It appears that greater efforts have been expended in attempts at effecting a separation of the zinc-lead-copper minerals, by improved, or new ore-dressing methods, than to the separation by a direct smelting of the mixed products. The separation of galena from iron, copper or zinc minerals, in the course of the ordinary wet concentration of ores, offers but little difficulty, and a large percentage of the galena can be separated without great loss, and such sep-

aration is always advisable where concentration must be resorted to by securing a suitable smelting product. The lead product so obtained can be collected until sufficient has accumulated to permit of separate treatment. The zinc-iron-copper minerals, however, do not differ enough in specific gravity to make their separation an easy one, and magnetic separation, as well as the various flotation processes, has been called into use in securing commercially clean products, the percentage of recovery varying greatly, as may be well understood upon studying the conditions under which the work is performed.

The writer has devoted many years of individual effort in attempts at securing a practical method of reduction for these complex ores and products, and finally concentrated his energies to devising a suitable smelting process, in preference to the means of mechanical concentration.

A study of the reactions met with in smelting operations show that zinc is reduced from its chemical combinations in much the same manner as is lead or copper, yet as this reduction takes place at a temperature above the boiling point of zinc, this metal is volatilized almost as soon as it is reduced. Inasmuch as it is imposible to obtain a perfect reducing atmophere in a large reduction furnace, the zinc cannot be recovered as metal, but must be collected as oxide, containing more or less impurities. The tendency of zinc to enter the slag is well known, and this is taken advantage of as a means of getting rid of the zinc contained in copper ores, and any smelting method which has for its object the recovery of zinc, must offer means of recovering the zinc that has entered into the slag. It is obvious that a furnace designed for the reduction and volatization of zinc must permit the easy escape of the zinc-laden vapors. The ordinary blast furnace, as used for copper smelting, is not adapted to such method, as the descending column of ore, fluxes and coke offers too great a surface to permit the unobstructed passage of the zinc vapors, and cases are recorded where such furnaces were put out of commission through the accumulation of zinc oxides in the shaft. Some form of reverberatory furnace would appear to answer the requirements much better, as the gases from this type of furnace meet with no resistance in their passage to the escape flue.

From the very beginning the Bessemer converter suggested itself to me as possessing the greatest possibilities for melting copper-zinc ores, for the oxidizing action of the air blown through the matte should liberate the zinc contained, as long as any copper remains as sulphide, as the zinc is reduced prior to the copper; any oxide of zinc which might enter the slag, or be contained in the gangue, would be reduced to metal if it could only be brought into contact with the liquid matte, for the reaction between the sulphides and oxides would bring about the reduction. This latter requirement could possibly be met by the use of a revolving converter, and this was the fundamental idea upon which my future work was based. At the time my first tests were made, the large horizontal Bisbee type of converter had not as yet made its appearance, and all attempts at smelting ores in the older type of converter were more or less unsuccessful, owing to the difficulty of maintaining the refractory lining. Early attempts at lining these furnaces with refractory brick met with failure, as the lining, especially at the tuyere zone, would be consumed almost as fast as it could be put in, and all additions of siliceous matter to the charge proved of little avail. The reason for this is not hard to find when one considers that the air enters through tuyeres located near the bottom of the converter, far removed from the surface of the charge, and the iron oxide formed at the tuyere zone, being chemically very active at the prevailing high temperature, unites with the adjacent lining, in preference to any ore that may be floating on the surface of the molten matte. To utilize this selective action of the iron oxide, and render it of commercial value at the same time, the converters were afterwards lined with silicious ore, and from that time on the converter has rapidly replaced the older, and more cumbersome refining furnaces, so that at the present time the Bessemerizing of matte is quite as common in copper refining practice as is the Bessemerizing of pig iron in the production of steel.

The inconvenience occasioned by the frequent renewal of the lining was more than outweighed by the benefits derived in the use of the converter, otherwise this process of refining would never have attained the important position it now holds. While the converter is admirably adapted to the refining of matte, it is evident that a number of fundamental changes would be necessary before it could be used in smelting ores. One of the first requisities of a commercial furnace is a serviceable lining, for a furnace requiring relining every other day or so could never obtain a foothold in metallurgical practice.

To carry out the converter idea in a smelting furnace, and at the same time conserve the lining, was the problem to be solved, and effort was made to profit as much as possible from the accumulated experience in copper converter practice. If the iron oxide formed during the regular converter operation is sufficiently active to disintegrate the lining, why should it not unite with the gangue accompanying an ore charge? Obviously, to prevent the eating away of the lining in the region of the tuyeres, it would be necessary to introduce the air at a point where the iron oxide formed would be in closer proximity to the unsmelted ore than to the more refractory lining. To accomplish this necessitates the introduction of the air from above the charge and away from the lining, as opposed to the method now in use. While years of smelting practice have shown the futility of blowing air over a liquid charge of matte in attempting the oxidation of the matte, the conditions are different, as soon as we deal with a partially fused charge, and especially if the semi-fused charge is agitated so as to conitnually expose fresh surfaces of ore, for under such conditions a rapid desulphurization takes place. The modern "pot roasting" methods are somewhat analogous to this method. Tests in a small way showed that a still more rapid desulphurization could be attained by forcing the air against the mass through a blowpipe, and small lumps of semi-fused ore would immediately melt and form a liquid pool, upon coming within the range of the air-blast. The use of blowpipes instead of the ordinary tuyeres formed the fundamental idea of overcoming the difficulties in maintaining the converter lining, for by their use the greatest heat of chemical reaction is generated within the ore itself, and away from the lining.

A small laboratory furnace was constructed embodying these features. It was a small horizontal sheet-iron cylinder, lined with refractory brick, and open at one end only. This opening served for the introduction of the ore, gasoline, air and for the manipulation of the blowpipe, the waste gases escaping through the same opening, yet above the point where the fuel was introduced. Various substances were tried in obtaining suitable blowpipes, a porcelain tube giving the best satisfaction, though graphite was also fairly serviceable. The blowpipe was manipulated by hand, and by directing the blast to the various portions of the ore, it was possible to smelt the charge in less than one-half the time required without the use of the blowpipe. Slag and matte were tapped after the charge was smelted, and the matte subsequently recovered from the slag upon cooling. The matte from a number of charges was united and refined, sufficient silica being added to combine with the iron, the operation being conducted in much the same way as the previous smelting operation, with

the exception, however, that in the refining operation the blowpipe was introduced into the matte, and served the additional function of a stirring device. It was possible to produce good-sized copper buttons in this furnace, and a very satisfactory removal of zinc could be effected, without any particular effort, as the slags contained but a fraction of 1% of that metal. These laboratory tests were highly encouraging and the carrying out of the process on a commercial scale was then attempted at Garfield, Utah.

FIRST COMMERCIAL TESTS.

The Garfield installation comprised two furnaces, placed end to end, yet separated by a connecting flue, the idea being the utilization of the waste heat from one furnace in heating a fresh charge in the second furnace, and after pouring the smelted charge and introducing a fresh charge, the second furnace, in which the charge was preheated by the waste heat from the first furnace, now received the initial supply of fuel, becoming the smelting furnace, while the first furnace became the heating furnace. In order to agitate the charge, the furnaces were made to revolve, yet in other respects they were very similar to the smaller laboratory furnace previously used. There were many structural difficulties to overcome, but the problem of maintaining the movable blowpipes was by far the most serious of the troubles met with, and finally caused their abandonment entirely. As long as they were used as blowpipes only, they proved fairly serviceable, yet when they were introduced into the matte during the final refining operation, much difficulty was experienced in preventing the accumulation of large lumps of chilled slag, at the end of the blowpipe, causing no end of trouble.

At this time, I will not enter into a recital of the Garfield smelting tests, yet in justice to myself, I cannot refrain from disclaiming responsibility for the many sensational statements sent out from Salt Lake City at the time. The representatives of The Mining World, as well as of other publications were more than anxious for an authoritative statement from me, yet all such requests met with refusal, for the furnace at that time was far from a commercial success, and I did not feel justified in making a statement.

While the furnace at Garfield failed to achieve the success attending the early laboratory experiments, thus again proving that correct theory does not necessarily spell commercial success, I was able to make certain observations that threw a greater light upon the problems involved. Upon introducing a charge of concentrate into the heated furnace, the matte forming ingredients rapidly melted and separated from the more siliceous gangue, which now formed a coating upon the lining as the furnace was rotated, the thickness of the coating being largely dependent upon the rapidity of feeding the ore, and was only entirely removed during the final refining of the matte. This observation clearly suggested an easy method of obtaining a siliceous lining in a converter, and a new furnace was designed to try out the discovery. As it was necessary to provide a revolving furnace, the prevailing "Anaconda" type of converter was abandoned, and a horizontal cylindrical furnace substituted therefor. Being a smelting furnace, suitable provision must be made for supplying fuel and ore, as well as air for the combustion of the fuel, in addition to the air supplied to the tuyeres. In order to permit of continuous operation an end opening was provided for the introduction of the ore and fuel, and one for the escape of the gaseous products of combustion. The tuyere boxes must be provided with means for regulating the air supply, so that the full pressure is available during the time the tuyereres pass underneath the charge, while the supply is gradually cut off as the tuyeres pass out from the molten bath.

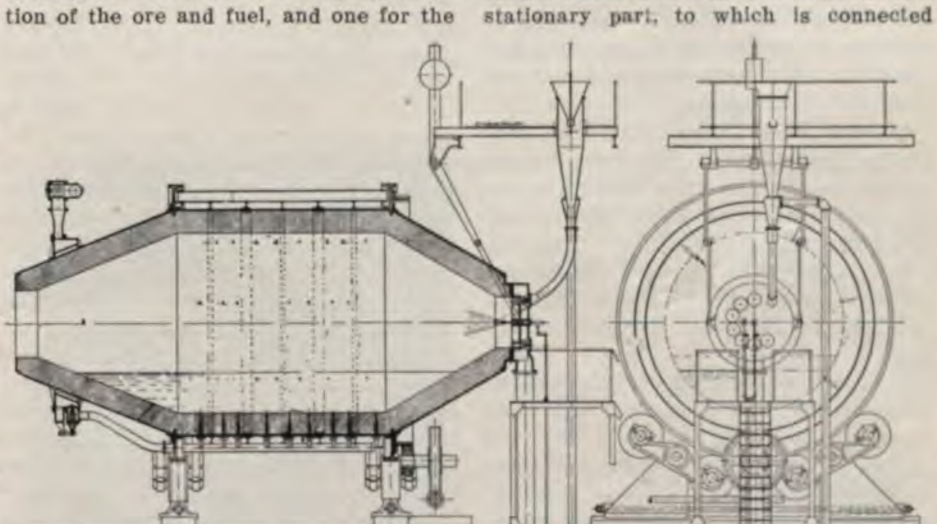
Being fully informed as to the requirements of the furnace, it would appear a simple matter to design an apparatus that would at once meet every requirement, yet where a radical departure such as this is attempted, many unforeseen mechanical problems are encountered when least expected, and the final completion of the work is carried far beyond the time originally allotted.

SECOND EXPERIMENTAL PLANT.

Anticipating many of the mechanical problems to be overcome, the second experimental plant was located almost within the city limits of Milwaukee, so that the highest specialized talent of the country could be called upon if need be, this being considered of greater importance, in this instance, than a convenient ore supply, and the wisdom of this decision was clearly demonstrated on more than one occasion. One by one the mechanical difficulties were met and removed, until finally a furnace was obtained that answered all requirements.

NEW FURNACE DESCRIBED.

The furnace is provided with two tuyere boxes, one of which is plainly shown extending along the cylindrical portion of the shell, as is also the air supply pipe, with its air regulation valve, extending from the wind-box along the conical end and through the trunnion to the tuyere box. The segment supported from the stationary ring of the wind-box by three cast-iron arms is the cam plate, which serves to open and close the air-supply valves connected with the tuyere boxes. The wind-box consists of a stationary part, to which is connected the air pipe leading to the high-pressure blower, and a movable part which contains the connections to the tuyere boxes, all of which is clearly shown in illustration. The wind-box contains a central opening communicating with the interior of the furnace, through which the ore is introduced, a cast-iron door swinging from the stationary ring preventing the flame from escaping at this end. This door contains, aside from the feed-pipe opening, two openings for the admission of air, and a smaller opening through which the burner nozzle is introduced. Opposite the air admission openings are two pipes, which discharge air into the furnace from a Connersville blower, which air is heated by a hot blast arrangement located in the main flue. The two openings for the admission of air also serve as a convenient means for observing the interior of the furnace during the smelting operation, as they are always clear and free from


Plan of 100-Ton Fink Furnace for Direct Bessemerization of Sulphide Ores.

smoke. When oil is used as fuel this is heated to near the flashing point, in order to obtain immediate combustion upon spraying into the furnace, and it is to prevent the chilling of this oil that the air is heated as described. The oil is atomized through pressure alone, making the combustion absolutely noiseless, and removing the disastrous blowpipe effect upon the lining so often obtained when air or steam is used to atomize the oil. The large curved pipe showing a portion of the feed hopper is the ore supply pipe, a better understanding of which may be obtained by studying the drawing showing the proposed 100-ton furnace. An ore seal is provided which prevents any back pressure from the furnace from communicating with the feed hopper, the ore being fed by revolving the disc shown, the rate of delivery depending upon the speed of revolution of the disc. Air is supplied to the feed pipe below the hopper, and by maintaining a flow of air into the furnace, the feed pipe is kept cool and free from flame and smoke.

The furnace is shown in the process of discharging slag, and by lowering or raising the furnace it is possible to accelerate or stop the flow. This process is wholly within the control of the operator, and the slag may be poured without disturbing the matte that has collected in the lower part of the furnace.

It is well to mention that the tuyeres are preferably left open to a very small extent, upon emerging from the ore charge to the time they are again about to be submerged, for by this operation the closing of the tuyeres would be entirely prevented, and, moreover, affording a much better mixture of the gases in the furnace than is otherwise the case.

Contrary to the experience obtained at Salt Lake City, the present furnace meets every requirement placed upon it, demonstrating the correctness of the theory, as well as its practical application. In direct contrast to the extreme corrosion of the ordinary converter lining at the tuyeres, the tuyere blocks in this furnace are scarcely attacked at all, which may be attributed to the chilling effect of the blast on the slag, as the tuyere leaves the matte, whereby a protective coating of slag is formed. Another remarkable observation in the operation of the furnace is the fact that the tuyeres seldom become obstructed, and "punching" is rarely necessary. This is probably due to the fact that any obstructions which might form, are smelted away during the progress of the tuyeres, from the time they leave the bath until they are again submerged, for during this time the openings are subjected to the direct heat of the smelting chamber.

Where more than two tuyere boxes are contemplated, as shown in the drawing for the proposed 100-ton plant, these must be so spaced that they may all be brought above the line of the molten charge, when it is desired to tap slag, in order to effect a quiet settling of the matte, which, of course, could not be obtained if the tuyeres were submerged and discharging air through the molten mass.

METHODS OF OPERATION.

Having now described the salient features of the new furnace, I will give a brief account of its operation. The furnace is first brought to a smelting heat by means of the oil flame, and the air from the high-pressure blower is discharged through the tuyeres. Ore preferably crushed to the size of walnuts, or finer, is now introduced through the feed pipe, the turning of the furnace preventing any accumulation at the feed end. If considerable sulphur is present in the ore, as in the case of concentrates, smelting takes place almost immediately, for the desulphurization is extremely rapid. The heated-air blast supplied by the Connersville blower is also a great aid to the desulphurization of the ore, in addition to supplying oxygen for the combustion of the fuel. The tuyeres, upon passing through the molten matte, cause a shower of small particles to be projected against the walls of the furnace, and in this finely divided condition the matte is most readily oxidized, and the period of desulphurization is greatly shortened. This fine spray of matte and slag exerts an absorbing influence upon any dust which may accompany the ore, so that the amount of flue dust produced is quite negligible. Any zinc in the ore is rapidly driven off during this smelting operation, and the matte which is collected is also quite free from zinc. The slag is poured from time to time, while the matte is allowed to accumulate until enough has collected to warrant further refining, at which time the slag is poured as completely as possible, and if the walls of the furnace now show an insufficient coating of siliceous matte, siliceous ore is added, although this is seldom necessary, since the matte originally produced is usually "white metal" containing but traces of iron, which requires only further oxidation for the production of blister copper.

The average copper contents of the slags produced was between 3 and 4-10ths of 1%, while the copper recovered was 99% pure, the assays being made by Dickman & Mackenzie of Chicago. At the present time no facilities are at hand for the collection of the zinc, and the only estimate which can be made as to the percentage eliminated, is based solely upon the absence of zinc in the slag, as well as in the finished product. At a future date an equipment will no doubt be installed to effect the actual recovery of the zinc, although the tests already made have fully demonstrated the correctness of the theory upon which the process is based.

While no tests have been made in smelting lead ores on a large scale, preliminary tests have given great encouragement, and I hope shortly to be able to report the results of some interesting tests, for, contrary to the general belief, the successful Bessemerization of lead sulphide ores is by no means hopeless.

While the smelting tests thus far made utilized oil for fuel, it must not be supposed that the furnace is limited to this form of fuel, as coal or charcoal may also be used to advantage. In case the latter forms of fuel are used, it is not necessary to reduce them to dust, and blow them into the furnace, as they are preferably fed in lump form with the ore, the combustion being brought about largely through the air from the tuyeres, the heat generated being in direct contact with the ore, rather than supplied by radiation from the furnace walls, as is the case when oil firing is used.

The furnace has not, as yet, been used for smelting carbonate ores, although there is no reason why it should not be applicable to this class of ores also, it being only necessary to supply a greater amount of carbon to the charge, and the tuyeres, instead of passing completely underneath the charge, should be stopped before the metal is reached, much in the same manner as in the refining of matte.

Although the furnace was primarily designed for smelting refractory zinc-copper ores, there are many advantages achieved in the smelting of strictly copper ores, also, as it enables the smaller producer to turn out blister copper, and, combining as it does, both smelting and converting operation in the same apparatus, great economies are achieved, both in the construction of the plant and in the operation thereof Whatever gold and silver may be contained in the ore is recovered with the copper and may easily be separated by the usual electrolytic method.

With fuel at 3 cts. per gallon, the average cost of smelting should not exceed $2 per ton, recovering the copper as blister copper, while the zinc is obtained largely as oxide.

A corporation known as the Fink Smelters Co., with the necessary financial backing, has been organized to carry on all business in relation to supplying or operating the new smelting furnace.

ORE CONCENTRATION ON TREMENDOUS SCALE

The production of merchantable iron ore, by means of wet concentration, from material which is too low-grade for profitable reduction in the blast furnace, is one phase of the great iron and steel industry which is in its infancy, says a writer in the Metallurgical and Engineering Magazine. That it has been successfully done on a large scale, leads to the belief that it is an important step toward the genuine conservation of our iron resources, and one that will be followed by others which, in time, will make available much ore now without commercial value. This means not only the utilization of low-grade deposits, but the conservation of the best ore for special purposes, or for raising the average grade and quality of a large tonnage of less desirable ore.

Fig. 1.—Iron Ore Concentrator, Oliver Iron Mining Company.

Special systems of concentration have had to be devised to meet the requirements of iron-ore production. The intrinsic value of a ton of iron ore is not great enough to warrant too elaborate a system of treatment, while smelting conditions demand an ore with as much lump and as little fine as possible. Tonnage and physical condition of the product, therefore, become important factors in this business. The former is equally important in the treatment of other low-grade ores, such as gold or copper. In these cases, however, it becomes necessary to resort to elaborate systems of grinding and fine concentration, which, fortunately, can be dispensed with in the concentration of iron ore.

In point of tonnage capacity of a single plant, there are no other ore-dressing mills in the United States which approach the magnitude of the largest iron concentrator. The great copper concentrating mills of Utah and Arizona, having individual capacities ranging from 3000 to 12,000 tons in 24 hours, are still small compared with the Trout Lake mill of the Oliver Iron Mining Company, with its capacity of 35,000 tons in 20 hours. And yet, owing to the more complex flow-sheet of the former, and consequently the larger number of machines used and greater acreage covered, they make an impression more nearly in keeping with their magnitude than does the iron concentrator.

TROUT LAKE MILL, OLIVER IRON MINING CO.

The first and larger of the two iron concentrating mills in Minnesota, was built by the Oliver Iron Mining Company, on Trout Lake, near the western end of the Missaba range, where the ore is lower grade than it is farther East. Here, also, the company has built the model town of Coleraine, beautifully situated on the north shore of the lake, and made attractive by substantial buildings, good schools, broad streets, cement curbing and sidewalks, and a system of artistic street lighting.

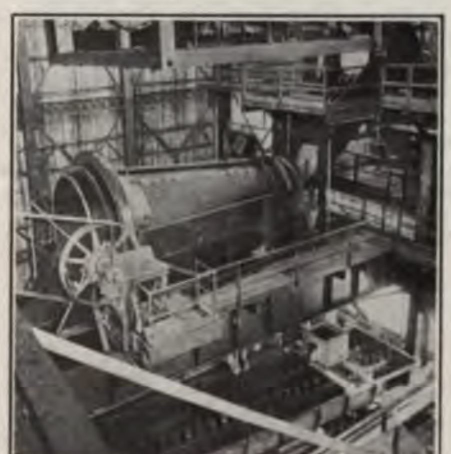


Fig. 4.—Interior of Concentrator of Wiscosin Steel Co., Showing Screen and Log Washer.

An exterior view of the mill is given in Fig. 1 and a flow sheet in plan and elevation in Fig. 2. The railway approach to the mill is over a long fill of earth and rock removed in stripping the iron deposits. This approach ends in a steel trestle, shown in the figure, reaching a height of 110 ft. above the ground, and giving the necessary elevation for a gravity flow of ore through the mill.

UNIT CONSTRUCTION.

The flow-sheet, Fig. 2, represents one of the five units, each under independent control. The capacity of each unit is 350 tons per hour, and as the mill is operated during two shifts of 10 hours each, or 20 hours per day, the capacity of the whole mill is 35,000 tons per day. The crude-ore bin for each unit will hold 500 tons of ore, or about 1½ hour-supply for the unit. The views shown in Figs. 4 and 5, although taken in another plant, represent similar construction in a unit of the Trout Lake mill.

As shown in the flow-sheet, the concentrating machines of a unit are one conical screen (2-in. openings), two 25-ft. log-washers, two 18-ft. turbo-washers, and twenty Overstrom concentrating tables, with the necessary complement of settling tanks, pumps and bins. The ore is sluiced from the bin onto a grizzly (6-in. openings), where large pieces of waste rock are sorted out, and large pieces of ore broken to pass on to the conical screen. The oversize of the latter passes onto a picking-belt (Fig. 5), the rock being picked out and discarded, while the lump concentrate passes on to the bin.

Fig. 3.—Iron Ore Concentrator of Wisconsin Steel Co., Nashwauk, Wis.

The 2-in. undersize of the screen flows to the log-washers on either side (Fig. 4). These machines produce a coarse concentrate which passes to the bin, the overflow being thickened and treated in the turbo-washers, which are practically smaller log-washers in which the feed is kept well agitated by numerous jets of water rising from the bottom of the casing. Between the logs and turbos are so-called "chip" screens or trommels, to separate and remove "chips" of rock

which are carried in the overflow of the log-washers. The turbo-washers produce a smaller size concentrate, and their overflow is thickened, and treated on tables. The table feed is clearly shown in the flow-sheet. The table concentrate is elevated by Frenier pumps, in two stages, dewatered and sent to the bin.

A 100-hp motor drives the conical screen, log and turbo-washers, and a 15-hp motor serves the twenty concentrating tables. The perforated plates of the conical screen are ½ in. high-carbon steel, and last about 100 days. The chilled-iron paddles on the logs last from five to six months. The decks of the Overstrom tables have been remodeled to suit the conditions, by removing the riffles and substituting a corrugated wood surface. This change resulted in increasing the efficiency of this department nearly 50 per cent.

The grade of the crude ore as it comes from the pits ranges from 35 to 42 per cent iron. The concentrate averages 57 per cent iron, and represents about 67 per cent by weight of the crude ore treated. The phosphorus content of the concentrate is slightly greater than that of the crude ore. All tailings are combined and sent to the Lake through a concrete flume, seen at the right in Fig. 1.

The pump and power station is situated on the shore of the lake, about 1¼ miles below the mill. The power plant, consisting of boilers, engine and 1250-kw generator, is capable of supplying twice the amount of power required in the mill, but the capacity of the pump is not much greater than the steady mill demand of 8000 gal. per minute. Water is raised a total height of 255 ft. above the lake, being delivered through a 30-in. pipe-line to a 110,000-gal. tank erected on a steel structure near the mill. The tank is in no sense a storage reservoir as it holds only about 15-minutes supply, but simply provides the necessary head of water for the mill.

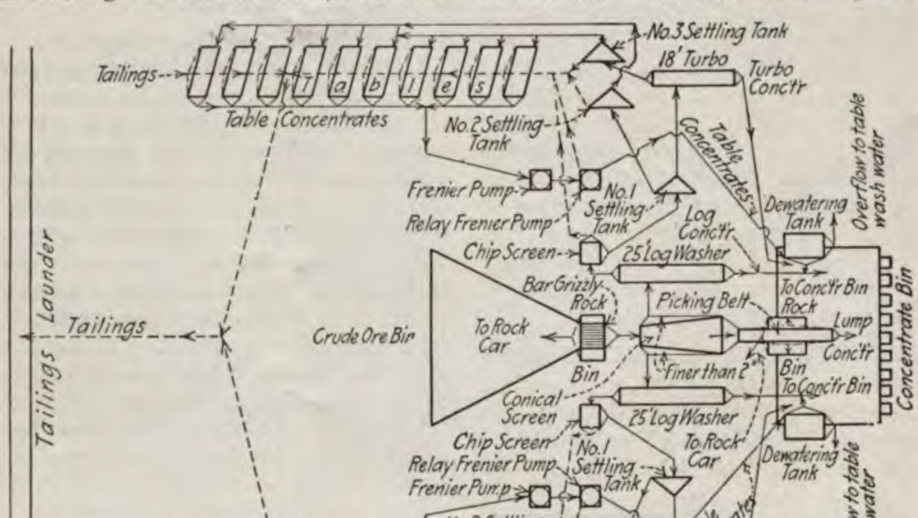


Fig. 2.—Flow Sheet, Trout Lake Concentrating Mill, Oliver Iron Mining Company, Coleraine, Minn.

THE WISCONSIN STEEL COMPANY'S MILL.

The second iron-ore concentrator built in Minnesota was erected by the Wisconsin Steel Company, to treat ore from the Hawkins mine at Nashwauk. With the exception of some changes, which will be noted, it was modeled after the Trout Lake mill, in which a test run of 1000 tons of Hawkins ore was made, to see what results could be obtained. The two main points of difference are in the method of delivering the crude ore to the head of the mill, and in the extent to which fine concentration is carried. In the Nashwauk mill, Fig. 3, the ore is elevated from the railroad ore-pockets by means of a belt conveyor, passing then through a concentrating system similar to that at Trout Lake, except that no concentrating tables are used.

By reference to Fig. 3, it will be seen that ore is delivered by railroad to two ore-pockets of 250-tons capacity. Below the pockets are shaking launders arranged to deliver to a common point. In operation they discharge alternately onto a 3-ft. rubber-belt conveyor set at an inclination of 19 deg. The conveyor is about 150 ft. long and discharges ore onto a 6-in. grizzly at the head of the mill at a point corresponding to the mouth of the crude-ore bin in the Trout Lake mill. The head pulley of the conveyor is discernible in the upper part of Fig. 3.

The operation of the shaking launders is controlled by one man at the ore-pockets, and the movement of the belt conveyor is governed by the men at its upper end, whose duty it is to sort out waste rock and break large lumps of ore which will not pass the grizzly. Should it become necessary to stop the belt, the man at the feeders is signalled by an electric bell, and the feed is temporarily stopped.

The advantages claimed for this system are: First, that it avoids the construction of the long approach required to deliver carloads of ore to the head of the mill; and second, that a more regular feed is insured by eliminating the possibility of sudden rushes of great masses of ore, which sometimes occur in a large bin. Irregularity of feed, of course, subsequently affects the efficiency of the screen and the log-washers,

as well as the quantity and grade of concentrate produced.

The decision to omit the concentrating tables in the Nashwauk mill was determined by the fact that only 3 per cent additional recovery could be made by their use; and the ore thus recovered, being fine, would be the least desirable of all the concentrates. When dry it would practically be dust, subject to loss in transportation as well as in the blast furnace, and altogether hardly worth the outlay of capital and operating expense for fifteen or twenty tables.

With the exceptions noted, the concentrating system at Nashwauk is practically the same as at Trout Lake. A minor difference is the use of small grizzlies instead of chip-screens to remove large particles of lean ore and rock from the overflow of the log-washers to the turbo-washers. The punched plates in the conical screen show about the same life as at Trout Lake. When the blades of the log-washers are worn thin, they are not removed, but are patched with pieces of white-iron bolted to the worn blades. The white-iron blades last from five to six weeks.

All concentrates are delivered to the same bin, and in order to mix the coarse and fine, a part of the stream of log-concentrate is diverted to the launder carrying turbo-concentrate before the latter enters the bin. Tailings flow out of the mill through an elevated launder which discharges onto an area of low land where the solid tailing accumulates, and the water drains back into the small lake near which the mill is built.

CONCENTRATION RESULTS.

The ore treated at Nashwauk is higher grade than at Trout Lake, and the product is proportionately of better quality. The crude will average 40 to 45 per cent iron and 15 to 16 per cent silica. The mixed concentrate averages 60 to 62 per cent iron and 3 to 6 per cent silica. Phosphorus is about two points higher in the concentrate than in the crude ore. It has been found profitable for the purposes of this company to concentrte crude ore containing up to 56 per cent iron. Eighty per cent of the iron in the crude ore is recovered, and the concentrate represents about 62 per cent by weight of the crude ore. Of the total product, 10 per cent is lump concentrate from the conical screens and picking belt, 80 per cent coarse concentrate from the log-washers and 10 per cent fine concentrate from the turbos. Sampling is done twice daily, all the concentrates being temporarily diverted to a steel bin provided for this purpose.

Steam-electric power is generated by a Parsons turbine and 500-kw generator, which gives power greatly in excess of the 125-kw required in the mill. The main unit is operated by a 100-hp motor, as at Trout Lake. The belt conveyor consumes abou 30 hp and the shaking feeders about 10 hp. A Prescott steam pump of 2500 gal. per min. capacity supplies water to the mill, the consumption being only 1200 gal. per min. This is proportionately less than is used at Trout Lake, due largely to the omission of the tables.

IRON-ORE CONCENTRATION A RECENT DEVELOPMENT.

The mills described are in operation only six months in the year, corresponding to the regular shipping on the lakes. The Trout Lake mill has finished its third season, and the Nashwauk mill its first. It is interesting to note that both mills far exceeded their rated capacities,

Fig. 5.—Picking Belt Below Screen in Wisconsin Steel Co.'s Plant.

practically by 100 per cent, and have given fully as good results as were anticipated. The Nashwauk mill was planned as a two-unit plant, but the single unit has proved ample for present needs, and the second may not be installed. As much as 8000 tons of ore has been treated in this unit in one day of 20 hours.

At Coleraine, Mr. M. H. Godfrey is general superintendent for the Oliver Iron Mining Company. Mr. Wm. Nicholls, who is superintendent of the Trout Lake mill, was formerly engaged at some of the large Western copper concentrtrators. Mr. C. J. Mott is assistant superintendent. The Nashwauk mill is under the management of Capt. Sellwood, of Duluth. Mr. B. W. Batchelder, of Nashwauk, is superintendent.

THE VAPORATION OF METALS

By PROF. J. W. RICHARDS*

Most practical metal workers know that some metals are volatile. No one knows many exact facts about this matter.

Metals have vapor-tension curves similar to that of water. Water at ordinary atmospheric pressure boils at 100 deg. C., or 212 deg. F. But at lower pressures it boils at lower temperatures; at half atmospheric pressure it boils at one-tenth atmospheric pressure at 46 deg. C., and at one-hundredth atmospheric pressure at 7 deg. C.

A point not generally understood is that an indifferent gas in contact with a volatile substance acts like a vacuum as far as inducing evaporation is concerned. Water evaporates in a current of dry air at any temperature whatever; the only condition being that the dry air be renewed as fast as it becomes saturated with the water vapor. Even solid water, ice, will evaporate in a current of dry air, although the temperature remains below the melting point of the ice.

All that has been said of water is true of metals. They all have definite boiling points under atmospheric pressure, lower boiling points at lower pressures, and can evaporate at any temperatures down even to their freezing points, if the pressure is sufficiently reduced. They will also vaporize at low temperatures in the presence of an indifferent gas, if the latter is renewed as fast as it is saturated with the metal vapor.

To illustrate the above principles, let us cite zinc, which boils under atmospheric pressure at 920 deg. C., but which has an appreciable vapor tension at as low a temperature as 289 deg. C. or 130 deg. C. below its melting point. This tells us that not only will zinc evaporate rapidly when melted, in a current of indifferent gas, but that even solid zinc can give off zinc vapor. Similar facts are true, although in a smaller degree, of many metals ordinarily considered as non-volatile. Silver, for instance, can evaporate from solid ingots which are being heated by direct contact with a flame, the gases of the flame carrying away with them more or less silver vapor, just as dry air can carry off water vapor from ice.

Evaporation and voltilization of metals can best be avoided by melting them out of contact with currents of gases; that is, by heating in closed vessels. This can be accomplished either by melting them in crucibles with covers, or by using electric furnace heating. The latter is to be preferred, and will be found much less expensive for power than is commonly supposed. I believe, for instance, that brass can be, at the present time, melted more cheaply in electric furnaces than by fuel, almost anywhere in the United States, with great saving of the zinc usually vaporized.

*Abstract of a paper read at the Allied Foundrymen's Convention in Buffalo, last month.

From Copper To "Gold Mines"

This space is reserved for the picture of A. F. Holden, the other eminent engineer who lent his name and gave his endorsement to the electrifying report on Alaska properties submitted herewith and which will be reproduced from month to month.

NOTED ENGINEERS JOIN BROKERAGE HOUSE IN A REMARKABLY PECULIAR PRESENTATION OF AN ALASKA GOLD MIRAGE.

We have received a few inquiries from readers who wished to know why we did not publish all of the "report" of Messrs. Jackling and Holden of the Alaska Gold Mines Company instead of the following "extracts." In reply we wish to explain that, if there ever was anything more than these "extracts" made public we have been unable to trace it. When Hayden, Stone & Co. sent out the letter inviting subscriptions to the stock they did it on the STRENGTH of the contents of these "extracts." Or that is the presumption, at least. That intending purchasers and investors at once became suspicious and have since kept hands off is indicated by the wording of nearly every line of publicity that has since been given the proposition. But read the "report" again. Here it is:

Extract From Report of Messrs. Jackling and Holden.

We have considered the PROBABLE capital requirements for a capacity of 6,000 tons per day, which contemplates a hydro-electric power plant; mine development and equipment including all the necessary living quarters, both at the Perseverance mine proper and at the mill, and driving the long adit tunnel. We BELIEVE that $4,500,000 will do this owrk.

Our belief is that the substantially INDICATED ore body is about 4,500 feet long by seventy feet wide. The value of the 600,000 tons of ore THAT HAVE BEEN MINED FROM THIS BODY IN THREE DIFFERENT LARGE STOPES INDICATES that a recovery of at least $1.50 per ton can be made. We BELIEVE that there will be 75 cents per ton profit in this grade of ore. The Sheep Creek Tunnel which will be driven on the vein as the main haulage level, will develop this ore body at an average depth of about 2,200 feet on the dip of the vein or about 700 feet deeper than present developments.

The character of this vein is similar in A VERY GENERAL WAY to other large deposits of gold ore in the same vicinity in which the values at a vertical depth of 1,600 feet, or 2,000 feet on the dip of the vein from its apex, are practically the same today as they were on the surface, and have been throughout the development of THE DEPOSITS IN QUESTION. We visited these mines and saw THEIR deep levels, and if there is any inference to be drawn from the continuity of THESE ore bodies, WHICH ARE NOT, HOWEVER ON THE SAME VEIN AS THE PERSEVERANCE, one MIGHT BE TEMPTED to say that there is a PROBABILITY of ore 2500 feet deeper than the so-called Sheep Creek Tunnel which we contemplate driving, BUT, while the PROBABILITY is there of the vein and values extending to great depth, THERE IS NOTHING TODAY TO WARRANT ANYBODY IN STATING THAT IT IS A FACT THAT SUCH WILL BE THE CASE.

There are substantially 50,000,000 tons in the ore body we consider definitely INDICATED. There is a PROBABILITY of another 2,000 feet to the east of the 4,500-foot ore zone previously mentioned which, from surface indications, would seem FAIRLY CERTAIN to contain ore. Beyond this is some 1,800 feet of the vein concerning which we have NO FINAL OPINION one way or the other, AS WE VISITED NO WORKINGS OR OUTCROPS from which we could secure sufficient data to form accurate deductions. While we cannot at this time state that there IS ore here, there were several SMALL MINES worked almost at the extreme east end of the vein on this property, which INDICATES that this 1,800 feet will undoubtedly produce considerable ore and PERHAPS LARGE QUANTITIES. If we do not consider this in the PROBABILITIES, it is certainly well within the POSSIBILITIES.

This letter is based solely on a consideration of $1.50 recoverable value as ore. If one should figure on lower values assuming 75 cents as the total cost of mining and milling, the tonnage now indicated is INDEFINITE, but certainly enormous. We BELIEVE that sound mining business will INDICATE that for the installation now proposed and for an operating period of, say, two years, IT WILL BE WISE TO CONFINE OUR WORK TO THE HIGHER GRADE ORE. There can be, in our opinion, little doubt that at some time in the comparatively near future A VERY MUCH LARGER PLANT than the one now proposed will be installed for the purpose of working a larger tonnage of the normal grade ore we now EXPECT will be developed, or of utilizing the apparently vast quantity of lower grade material.

The INDICATED earnings from the installation now contemplated are approximately $1,500 000 per annum. Considering the TREMENDOUS POSSIBILITIES, and we use the word "tremendous" advisedly, we BELIEVE this mine to be a LEGITIMATE purchase at $15,000,000 and A BARGAIN at $12,000,000, provided that, in both cases, a development, equipment and working fund of $4,500,000 is made available. You must understand and appreciate that we do not consider the 6,000-ton per day development and installation as the ultimate possibility of the mine or anywhere near it. The POSSIBLE tonnages of ore INDICATED in this property APPEAR to be greater than any vein deposit WE know about.

We EXPECT the first unit of the new mill to be in operation on or before January 1st, 1915. We really BELIEVE that, barring accidents the time MAY be made July 1st, 1914.

(Signed, July, 1912.)

D. C. JACKLING.
A. F. HOLDEN.

How Spelter Is Sold

By W. R. INGALLS*

The American zinc industry has escaped any general consolidation and there has not developed in it any single concern of sufficient power even to attempt to regulate the price. This may be ascribed primarily to the nature of the occurrence of the ore deposits which are worked in a multitude of mines whereof a general control would be a hopeless undertaking. Given therefore an open supply of ore and a metallurgical process for its reduction that does not so strenuously demand mixtures as does the process of lead smelting, the metallurgical side of the industry is also bound to remain open. There are other conditions favoring the maintenance of that condition, but what I have stated will suffice as a broad generalization. There have, indeed, been numerous consolidations of groups of works during the last 20 years, but these have been simply promotive of efficiency, not restrictive of competition. In many cases the vendors of works have promptly built new works with the money received for their old ones, and have successfully continued in the smelting business. With such an ability, what would be the use of any trust organizer buying up all the works of the country? However, there has been during the last 15 years a natural segregation of interest, which has been merely a manifestation of the modern tendency to substitute strong industrial units for small and weak ones, and this of course has had an effect upon market conditions, especially in the conversion of the brokerage houses into producers.

ELIMINATION OF THE MIDDLEMEN.

Twenty years ago the production of spelter was largely made by small concerns, mostly of small capital and frequently on the ragged edge of insolvency. Their policy was commonly to combine smelting and speculation and their purchases of ore and sales of spelter were largely governed by their forecasts of the market. When pinched by some unforeseen turn and caught with a stock of spelter on hand their lack of resources compelled them to unload at a sacrifice upon some one of the metal houses able to carry the stock and distribute it to consumers later on. These metal houses often were called upon to make advances to smelters and through the combination of their banking and merchandizing facilities became great factors in the business.

As the smelting industry became concentrated in fewer and stronger hands the necessity for such middlemen disappeared, and the latter being desirous of maintaining their well organized system of merchandising their only recourse was to go into the smelting business themselves, whereby their purview was extended beyond the production of zinc as spelter and to the zinc-ore market, but none has actually entered upon the production of ore.

THE SMELTING INTERESTS.

A list of the American zinc smelters has been published repeatedly, wherefore it is unnecessary to repeat it here, but it will be of interest to present a list of the controlling factors of the industry, which is given herewith:

Name.	Retorts.
Am. Zinc, Lead & Smg. Co., 3 wks.	11,488
American Metal Co., 3 wks.	11,840
Chanute Zinc Co., 1 wks.	1,280
Beer, Sondheimer & Co., 1 wks.	4,256
G. E. Nicholson, 2 wks.	5,696
Collinsville Zinc Co., 1 wks.	1,536
Edgar Zinc Co., 2 wks.	6,800
Granby Mg. & Smg. Co., 1 wks.	3,840
Grasselli Chemical Co., 1 wks.	9,216
Hegeler Bros., 1 wks.	1,800
Illinois Zinc Co., 1 wks.	4,460
Matthiessen & Hegeler, 1 wks.	4,380
Nevada Zinc Co., 1 wks.	648
New Jersey Zinc Co., 4 wks.	16,116
Pittsburgh Zinc Co., 1 wks.	448
Sandoval Zinc Co., 1 wks	896
U. S. Zinc Co., 1 wks.	1,680
United Zinc & Chem. Co., 1 wks.	3,680

It will be observed from this list that there are five concerns each possessing upward of 6000 retorts. Of these the Edgar Zinc Co. is controlled by the United States Steel Corporation and supplies it with spelter to a large extent. There are seven concerns with less than 2000 retorts each. There are six concerns with from 2000 to 6000 retorts. Of these, the Matthiessen & Hegeler Zinc Co. and the Illinois Zinc Co. consume the major part of their product in the manufacture of sheet zinc. The New Jersey Zinc Co., the American Zinc Lead and Smg. Co. and the Granby Mining & Smelting Co. are the only ones of these smelters who have any mining interests worth mentioning.

KINDS OF SPELTER.

At the annual meeting of the American Society for Testing Materials in June, 1911, Prof. William Campbell, of Columbia University, chairman of the committee on "Non-Ferrous Metals and Alloys" reported a classification of the kinds of spelter, the figures representing the maximum percentages of impurities allowable. This classification is rational and corresponds substantially to the understanding among American zinc smelters.

The trade recognizes different grades of some of these kinds of spelter. Thus, "Horsehead" and "Bertha" spelters are considered to be superior to any other brands of high grade spelter and realize the highest premiums. "Glendale Refined" is, so far as I am aware, the only kind of intermediate spelter. This is made out of especially selected ore. Prime Western spelter corresponds to the "Good Ordinary Brands" of the European market. The bulk of the American spelter product is of this class. There is considerable variation in the quality of the several brands. Most of the Prime Western spelter is now made out of ore from the far West. There are some smelters who continue to use mainly a good grade of Joplin ore and produce a spelter standing between Prime Western and Brass Special and realizing therefor a small premium.

KINDS OF SPELTER.

KIND	Pb.	Fe.	Cd.	Total not over
A. High grade*	0.07	0.03	0.05	0.10
B. Intermediate*	0.20	0.03	0.05	0.50
C. Brass special*	0.75	0.04	0.75	1.20
D. Prime Western	1.50	0.08	....	....

*To be free from aluminum.

The price commanded by the high grade spelter is so much above that realized for Prime Western that to all intents and purposes it is a different metal. The premium runs anywhere from 2 to 4c per lb.† The premium for intermediate spelter is usually from 1 to 2c. per pound. Brass Special fetches a premium of from 5 to 25c. per 100 lb. The high grade and intermediate spelters are made by few concerns, which are able to command their own terms. Brass Special is made by many concerns and the supply of it is relatively abundant. In speaking commonly of the price of spelter, the price for Prime Western is meant.

MARKETING.

In the main the producers of spelter market their own spelter, i. e., they sell it directly to consumers. So far as I am aware there is none sold regularly through the metal selling agencies on commission‡ but these agencies not infrequently buy outright from some of the weaker smelters still remaining, who find among them an ever present market at a price. It goes almost without saying that with so many producers of spelter the competition among them to dispose of their product is keen. In this market in fact the common condition is reversed, the concentration being on the consuming side, not on the producing. The

*Editor Engineering & Mining Journal in October 26 issue.

†The supply of high-grade spelter could no doubt be greatly increased if there were need for it, and prospective competitors in this market would find it hazardous to reckon upon the full premium now realized.

‡I exclude from this statement the sales by L. Vogelstein & Co., for the American Zinc, Lead & Smelting Co., and of Beer, Sondheimer & Co., for the National Zinc Co., where the agents are interested in the respective producing companies.

United States Steel Corporation alone takes upward of 30% of the entire make of prime western spelter, and the activity in the spelter market is likely to depend upon whether that company is buying or not buying.

GENERAL CONDITIONS.

The conditions governing the marketing of spelter are in the main the same as in the marketing of copper which I have described in a previous article. The so-called "spot" business is essentially of a retail character, the main business in the metal being in contracts, which are made for a longer or shorter period ahead according to notions of what the future is going to develop. The stock of spelter in the hands of the smelters is always relatively small. Anything like 25,000 tons is considered large, but in fact that is only about the production of one month and includes all kinds of the metal. At some times there may be a practically complete disappearance of stocks, as for example, during the last year, and buyers who must have some metal for immediate delivery are likely to be required to pay stiff premiums, but such are in no way representative of the broad commodity market because but relatively little business is done under those conditions, the bulk being in contracts anticipating requirements.

When contracts are made for a long time ahead there may be a differential in the price, plus or minus, according to the preponderance of views respecting the future. Most of the smelters are governed by their position as to ore supply. Those who take in ore under contract, on a sliding scale, desire normally immediately to sell spelter against it. The trend toward a rising market must be very well defined and certain to cause them to adopt a policy of reserve in their selling. The smelter who buys his ore as needed or as offered will always be governed in his attitude toward the spelter market by the quantity and cost of his stock.

ST. LOUIS THE BASING POINT.

It become the custom in the American spelter market to adopt the price at St. Louis as the basis for contracts and business generally. The spelter may not even pass through there on its way to the buyers. Some spelter is actually sold in St. Louis, but a very large quantity is sold in New York on St. Louis basis. The price at New York, if ever it be necessary to refer to it, is simply the St. Louis price plus 15c, per 100 lb, which is the freight rate from St. Louis to New York.

St. Louis is a natural basing point, because the major part of the consumption of spelter in the United States occurs at places between it and New York. Upon the rare occasions when European spelter is imported through New York, as in September, 1912, New York may become an independent basis point and there may be a variation from the normal freight differential, but this is only temporary. Importations of foreign spelter will begin, of course, when consumers in the immediate vicinity of New York, or in Connecticut, can be supplied more cheaply than from the western smelting points, while the latter may still retain the interior market.

SPECULATION IN SPELTER.

There is more speculation in spelter than there is in copper. The fluctuations in the price are rapid and often violent, the sellers of spelter for distribution are numerous, no single interest is predominant, all of which conditions contribute to the absence of aversion to speculative participation in this market such as exists in the copper market. There are many smelters who will sell spelter to anybody who wants to buy it, hold the spelter and issue certificates representing it. These certificates may pass from hand ' hand and be redeemed after five or six endorsements have been made on them. They correspond, of course, to any warehouse receipt. It is, however, only at times that there are general transactions of this kind.

Similarly as to transactions on the New York Metal Exchange. They are never of any great volume or significance. Long periods may elapse without there being any at all. Then several hundred tons may be sold in a day. These reflect speculative business. Consumers do not buy through the Metal Exchange. Most of the smelters do not try to sell through it or indeed pay any attention to it. Some smelters are represented upon it and may buy up what is offered there, especially if it be desired to clean up the market of speculative spelter. In the same way there are transactions from hand to hand in St. Louis, although there is no organized exchange there, the business being of the nature of that of a curb market. The entire volume of the business of this kind, both in New York and St. Louis is only a few hundred tons per month and is insignificant in comparison with the marketing of the bulk of the spelter product, which is done directly between producers and consumers. Almost without exception the smelters give preference to orders from consumers over orders from dealers, and frequently give the former as much as 5c. per 100 lb. advantage in price, and even more.

The real spelter market being established by private transactions between producers and consumers the information reflecting the market can come only from them. Among such transactions there are often considerable differences, the means of exchanging information in the spelter market being distinctly inferior to those of the copper market. Some consumers do considerable "shopping." Others do not. Some who do so ordinarily may upon certain occasions make a negotiation with some one smelter without letting anybody else know that he is in the market. The direct market, if I may use that term, is often quite different from the speculative, or semi-speculative, street market. The quotations made on the New York Metal Exchange do not ordinarily command any serious attention anywhere. Before accepting any quotations made there it is necessary to know whether anybody trading in spelter was present at the call and whether the price was the result f a genuine transaction. If nobody who wants to buy or sell spelter be present at the call it is easy of course to bid up, or offer down, the price ⅛ to ¼c. above or below the real market.

The conditions above recited explain the contradictory reports about the spelter market that frequently are in circulation. In cases of discrepancy the high figures are generally to be rejected on the probability that they represent merely prices that are squeezed on a small order required under special conditions or in speculative business that is small in volume anyway.

FOREIGN RELATIONS.

The tariff on spelter causes the American market to be independent of the European market during most of the time. Formerly, American smelters used to dump a good deal of spelter upon the European market at certain times, but during recent years no such opportunity has arisen. On the other hand, we have lately witnessed circumstances in which we were upon the verge of importing European spelter, duty paid, and have actually made such importations.* At these times the European market was a restraining influence to a further rise in our own. Similarity, upon other occasions, the possibility of exporting spelter has checked a decline in our market. Except for these conditions the European market and American market may display wide disparity and doubtless will continue to do so so long as our producers are protected by the tariff on zinc ore and spelter.

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*We are, of course, importing foreign zinc ore all the time and smelting it in bond, the product being exported or entered for consumption according to the market conditions of the moment. The duty on imported spelter is 1⅜c. per lb.; on zinc in ore, 1c. per lb.

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CONTENTS:

Have you noticed how little the liquidation in the stock market during the past month has affected Alaska Gold Mines shares? Its great strength and steadiness is most likely due to the fact that the public has so far had sense enough to steer clear of it. Utah Copper holds "strong" for almost the same reason, the difference being that while Alaska has never left the hands of the insiders, most of Utah Copper shares that had been "distributed" have gradually gone back home during the market supporting "movements" of the insiders.

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Hang on to the bed-post and let this, from the mining department of Goodwin's Weekly, whiz by; if you let go it is possible you will fall into the fireplace: "The hills and flats are producing millions of pounds of copper. Hence copper can be made from nothing. Col. D. C. Jackling, the man who "makes mole hills out of mountains" was the wonder worker in this instance. * * * The convivial husband no longer will seek to deceive his distrusting wife with cloves, limberger or such sorry make-shifts; he will buy a paper and read about the Jackling coppers."

D. C. JACKLING INTERVIEWED ON BUTTE AND SUPERIOR

The Anaconda Standard of Monday, December 9, contained an interview with General Manager D. C. Jackling, of the Butte and Superior company, "before the Salt Lake mining magnate left for Alaska, where he will spend a month inspecting HIS properties in the Juneau district." Mines and Methods reproduces from the article the portions having particular reference to the changes being made in the Butte and Superior mill, as follows, the capitalization of words being our own:

"While our new section of the mill has not been running long enough to make any definite statement as to the complete efficiency of our new process, we are confident that we have installed the correct system and from our three-day run, in addition to the EXHAUSTIVE TESTS that the system had been given before the installation of the new section, we BELIEVE we are on the right track," he said.

Mr. Jackling added that THE NEW PROCESS IS MUCH ON THE ORDER OF THE PROCESS USED IN THE TREATMENT OF THE ORES OF THE UTAH COPPER COMPANY THROUGH UTAH AND NEVADA. A roughing table takes the place of jigs and THE PROCESS IS A DRY ONE instead of the WET SYSTEM formerly used.

The new section will treat 600 tons of ore each twenty-four hours, and with the other sections of the mill changed to this process, the tonnage of the Butte & Superior will be nearly 1,800 tons per day.

"Our new process of treating the highly refractory zinc ores is most satisfactory and it means a great deal to your community," said Mr. Jackling. "The north and some of the east sections of the Butte district are wonderfully rich in zinc, but heretofore a solution for a process of treatment has been most difficult as well as expensive. We have every reason to BELIEVE that the difficulty has been solved.

Manager Jackling's statement concerning the merits of the new "solution for a process" should not, we think, be taken too seriously by either investors or engineers. The substitution of roughing tables for jigs and making the process "a dry one instead of the wet system formerly used," (whatever is meant by that), does not seem to indicate much in itself. Neither is there any satisfying assurance in the statement that "we have every reason to BELIEVE that the difficulty has been solved." Orther statements of the general manager in the paragraphs quoted above are fully as lacking in conviction and, when we stop to think of the change after change made in the Utah Copper, Ray Consolidated and other milling plants directed by Manager Jackling with such barren results—from an economic and metallurgical standpoint—we may be pardoned for expressing the opinion that the manager was not overly sure of his ground when he admitted to the Standard reporter that "we BELIEVE we are on the right track," nor that he was not even then evolving ideas for additional "remodeling" campaigns for the future.

Mines and Methods is not questioning reports concerning the great magnitude of the zinciferous ore deposits in the Butte district, nor will it be displeased to hear that the Butte and Superior company has found a method by which the ores can be made to yield a product that can be profitably marketed. It is reported that Senator W. A. Clark, rated as one of the shrewdest mine operators in the world, is employing the best available metallurgical and engineering talent in a determined effort to discover a method by which ores similar to those contained in the Butte and Superior property, and opened up in his mines, may be profitably handled. He has not as yet been successful, though of course his engineers are not ignorant of the methods employed at the Utah Copper plants, the Ray Consolidated or Nevada Consolidated.

Before it is possible to judge what advancement the Butte and Superior management has gained with its new "dry" process over the old "wet" one, shareholders in the company will (or ought to) require enlightenment on many things connected with the operation of the process. An explanation of the characteristics of the ore, what elements go to make its treatment difficult; what grade of product must be made to get results in the market; what the mill was doing before the changes were undertaken, and wherein a betterment of results is secured by the change. While the Butte and Superior company is rated as a powerful one and the expense of frequent remodeling could be borne as easily as it has been by the Utah Copper and other companies, the shareholders will hardly be content with reports showing simply that so many tons of ore were treated and so many thousands of pounds of zinc were contained in the concentrates—that will not mean much in its application to such rebellious material as the zinc ores of the Butte district are known to be.

MARKETS "FUNDAMENTALLY" SOUND

All followers of the market dope on copper production and consumption, and particularly as it has had anything to do with the ups and downs of prices of the stocks representing the "leading low-grade porphyries," must have noticed the well-worn use that has been made during the year of the word "fundamental," with all the prefixed and affixed glowing raiment with which it has been clothed. When the talent has been shooting holes in the market, such dopesters as Babson, Shotwell, Walker, Ben Hite, Hayden, Stone & Co., and the Boston News Bureau, have all made it "as plain as mud" that all conditions were "fundamentally sound."

But, as the year draws to a close, it is painfully evident that none of these "authorities" have cut even close to the mark. Maybe they have not tried to. At any rate that is the most charitable view to take of their efforts; and if they have not tried to be fair with the public they are all guilty of saying things designed to interest the public in stocks which they knew to occupy positions they were not entitled to occupy and which, if purchased, would bring financial disaster to those who followed their market prognostications.

A few months ago most of these public advisers gave space to figures showing that the visible supply of copper in the world had dropped to less than 100,000,000 pounds; that "fundamental condition" were such that, before the end of year 1912, the world's markets would be stripped of copper metal and that "a runaway market" was to be "feared."

The Copper producers' report for last month must have been an awfully bitter pill for the "bull market" dopesters to swallow. It read as though some of the producers had become tired of the deception that had been going on and that it was time to straighten things out a little. The report in question was made to show that the visible supply of copper had increased during he month 9,419,095 pounds, and that in face of the fact that production had decreased during the same time 10,710,013 pounds. Further than that, the report shows that the world's supply of the red metal, instead of being about wiped out as predicted by the "dopesters" enumerated above, is again nearing the 200,000,000-pound mark. Domestic deliveries, under the "fundamentally sound" conditions so industriously paraded fell off more than 14,000,000 pounds during November, with the export market looking gloomy, as well.

It is all right to take a cheerful view of things and thus help to remove distrust and make business conditions better, but to distort the truth and hide true conditions for the purpose, merely, of aiding the manipulation of stock-distribution schemes of most questionable character, is something that ought to be stopped by the postoffice department, if it is impossible to reach it in any other way.

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BRAND NEW METHODS OF FIGURING ORE RESERVES

According to statements made in the syndicate press for the low-grade porphyries a new and rather unique method of piling up tonnage reserves has been discovered. The first illustration of the new scheme has been applied to Chino. One of "two authorities" is made to say:

> It will be recalled that the latest official estimate was, approximately, 55,000,000 tons, averaging 2¼ per cent. In mining this ore, however, a very large amount of other material will have to be moved.
>
> In previous calculations this has been looked upon as waste. As a matter of fact, it contains very large quantities of ore of low grade, which, with the efficiency developed at modern concentrating mills, can be treated at a good profit. It has, therefore, definitely been determined that much of this can, and will, be sent to the mill.
>
> Without going into too much detail, the net result is that instead of 55,000,000 tons of ore, averaging 2¼ per cent it is now estimated that there have been developed at the Chino property no less than 90,000,000 tons, averaging 1.83 per cent. This is the quantity of ore that will eventually be mined and milled from the areas originally developed.

In other words, where it was formerly the plan to say how much "fully developed, probable and possible ore" was available, together with the copper contents of each class, they now simply add to the total figures estimating fully developed ore by reducing the grade to any convenient average. In this way the "fully developed area" may be extended to the limits of a company's acreage, while no loop-hole will be left through which to question the particular value or lack of value of the added ground. The way this information concerning Chino is being exploited carries a conviction that the time is near at hand when a new bond and convertible stock issue, "for the purpose of enlarging the milling capacity," will be announced. This is further indicated in the following paragraph, taken from the article quoted from:

> The fifth section of the mill has been put into commission and there shrould be no difficulty in the mine's working up to the full mill requirements by the first quarter of the new year.

The only trouble about this report concerning what the mill is doing is that it does not seem to be true. In a dispatch from Silver City, N. M., to the El Paso Herald, dealing with Chino affairs and dated Nov. 21, we find this: "TWO SECTIONS of the big concentrator at Hurley are kept busy. LACK OF WATER prevents the concentrator from being run to its full capacity." It is up to investors who are being educated to believe that Chino is conducted on the square to reconcile these statements and weigh the methods used to add millions of tons to ore reserves.

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WANT THE COUNTY TO PAY

The expected has happened with respect to one feature of the Bingham strike. The Utah Copper Company which, on the 15th of October, was reported to have had no less than 525 "fighting deputy sheriffs" on its pay roll at $5 per day "and found," and which still probably has about 300 armed "deputies" prowling around looking for Union ghosts which seem to be frightening the wits out of its managers, has secured the signatures of some of the other Bingham companies and presented a petition to the county commissioners demanding that these armed deputies be paid by the county.

When these men were hired to "strike terror to the hearts" of the dissatisfied miners a general election was soon to be held and the governor, the sheriff and county commissioners—being candidates for reelection—without figuring on anything else, knew it would be suicidal to the Republican ticket to involve the county in any such expense as the employment of this needless army of "gun fighters" would entail and, following several conferences between officials of the county—including the governor—and the mine managers, the statement was given the broadest publicty that while the sheriff would recognize the army as deputy sheriffs by "swearing them in," they would receive their pay from the mining companies using them.

The election is over, the Republicans have won, and now the companies are tring to saddle the tremendous and altogether uncalled-for expense of the "deputy" payroll on to Salt Lake county. The county commissioners have decided to "stand pat" and have denied the petition, but of course the companies will not take this "no" for answer. The matter will come up again in some guise or another. Taxpayers should watch the game.

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The "low grade" porphyry reporters, under direction of their ringmasters, are now spreading out the big hay mattress to catch the high tumblers who vaulted from "the survival of the fittest" springboard something over three years ago. For additional particulars read the "merger" dope now being ladled out.

OKE AND NOXIOUS FUMES RETARD GROWTH OF SALT LAKE

TE.—The following article dealing with the deplorable smoke and fume nuisance with which this city has to contend was in type and ofs had been read on the 13th of the present month. Two days later the morning papers—seemingly inspired, and as if by revelation—"rose occasion" and waded into the smoke problem on its own account. The of its first article is found in the untenable premises taken on which to ts campaign and the intention since displayed to make the matter a n of petty politics, thus defeating any legitimate purpose that its labored might otherwise have produced. The particular feature referred to in t article was the haste with which the paper dismissed as immaterial t played by the valley smelting works, in this fashion: "Our dry at- re offers easy escape for the volumes of soot; such immense smelting as might pollute the heavens are so far removed from the city that ed not enter into the equation." The motive for injecting that asser- to the daily paper's introductory remarks may possibly be discovered eading the following presentation of the subject:

may seem a little out of place i-technical mining publication s and Methods to take up a ch as is outlined in the title rticle, every progressive and g resident of this city must h us that the diversion, if such it signated is fully justified by the ic conditions under which (and the good people here are com- struggle for freedom from the isonous filth which overhangs ally beautiful valley every day r that the atmosphere is not y clarified by wind storms, s of commercial exigency, ring growth and civic pride ave had a paralyzing effect on apers and the organizations been dealing with the subject time (until a few days ago and ly co-incident with the placing of this article in type) and nothing has been accomplished.

About the first of the present month the chief of police and chief of the fire department reported that smoke conditions in the city were much improved. The very morning that that report was made in the papers a photographer might have gone out on the hills either to the north or east of the city and taken a picture that would have shown the city entirely submerged in a heavy, fog-like mantle through which nothing but the tops of the highest buildings could be seen. People coming from outside localities to the business district were attacked with fits of sneezing, coughing and other evidences of distress, including a stinging, burning sensation in the eyes, nostrils and throat, while the faces and hands of tender-skinned individuals itched ad tingled

Down-town residents become accustomed to this and think little of it; but the strangers in town—the very class of people that we would have settle and make their homes here and those who talk about us and the conditions prevailing here when they leave—suffer more than we do from the conditions mentioned and consequently are unfavorably impressed. That first, unfavorable impression hurts the town—hurts its growth and hurts its business to a degree that evidently is not half understood or appreciated by the community at large, nor by those most interested from a business standpoint in seeing every condition tending to material advancement improved.

WHERE WE DECEIVE.

The assurance is usually given outsiders that this condition is not a permanent one; that it is only on rare occasions—a few days in the year—that our so-called smoke nuisance is manifest. But our Commercial club, real estate association, medical fraternity, civic improvement societies, "city beautiful" clubs and all other classes of residents, fully realize that such statements are mere subterfuges and not in keeping with the truth; so that, if anything of real, tangible benefit is to be accomplished, we must first cease trying to deceive ourselves and the outside world—and eradicate the evil.

Thousands of dollars are annually expended in publicity campaigns having for their purpose the advertising of Salt Lake as a natural and magnificently endowed health-building sanitarium. In the abstract this is true. We have a most

ture was taken from a front window of the Kearns block on the afternoon of the 13th of this month. The view is l the east—the finest residential section of Salt Lake. It was impossible for the camera's eye to penetrate this pall moke, noxious fumes and gases for more than a block, except to the south, where the atmosphere had cleared fficiently to admit a dim, sickly ray of sunshine. See any cause here for a protest against the nuisance?

beautiful valley here, almost surrounded by majestic mountains. These are cut with deep canyons through which flow streams of sparkling, pure water. Uncontaminated this water is made to supply the city which, by rights of location and natural environment, should and could be made to cause every visitor to become an unsolicited champion of its merits as a place in which to live. We have springs of hot sulphur water and splendid bathing establishments therewith connected; we have, only a few minutes' ride from the city, the most famous body of salt water in the world, with its great resort and bathing facilities; we have mountain resorts and trout streams, sylvian lakes amid the woods and crags at elevations of thousands of feet above the Salt Lake basin, where those so inclined may go by motor car or train within an hour and escape the summer heat; in fact, we have everything required to make this city and valley a little Paradise on earth, WITH JUST ONE DRAWBACK that should not be tolerated for a longer period than is necessary to remove it for good, and that is the smoke and fume nuisance.

ROOT OF THE EVIL.

Years and years ago city ordinances were promulgated that were designed to eradicate the smoke nuisance and there was a general movement by the operators of steam-generating plants manufacturing establishments, public buildings, etc., to meet the requirements of the law. More and more attention has been given to the enforcement of these ordinances as the years have passed, but the seat of the difficulty—the root of the evil—has not been reached. The storekeepers, the good housewives all over the city, and particularly those having the direction and care of the finer homes, all know what it is to have delicate draperies and window hangings blackened and smudged at every attempt to throw the house open for airing. It has been learned that not only does the soot and dirt make its presence known by the discolorations produced, but that the damage does not stop there—the difficulty cuts deeper.

The soot and other more or less solid particles that make up the visible murkiness of the atmosphere is found to have absorbed and assimilated the sulphurous, arsenical fumes and gases that are discharged into the air in tremendous volume by the smelters on the margins of the city to the south. These fumes and gases are brought in by the air currents when they are moving from the south and their insidious work is detected not only in the ruin of delicate fabrics in the homes whenever cleansing is attempted, but their effect is plainly marked by the distress of the aged, feeble, sick and delicate people who find increasing difficulty in escaping the injurious effects of breathing these noxious substances, particularly if already suffering with bronchial and nasal afflictions. Physicians universally declare that the chemical combinations produced by the admixture of the substances complained of are most harmful and productive of various diseases, but with all this the most severe censure one hears is that this or that owner of some building has failed to comply with the ordinances requiring that devices be installed to make better the combustion of coal consumed in the heating or steam-generating plants connected therewith.

REMEDY? MOVE SMELTERS.

Viewed from different standpoints it appears that one of two things will have to be done: The people here will either have to work with a set determination of making this a magnificent city of homes, already famous for its climate and other advantages (some of which have been enumerated above), or they must yield to another viewpoint and allow the city to grow into a second Pittsburg—a smelter town. Which will be best, which do we want? are the matters to be decided; and that once settled, it is up to us to apply the remedy that will brings results. There is no middle ground. What shall we do?

The day is rapidly approaching when the plants to the south of town—as a result of depreciation and disintegration, coupled with the newer ideas and processes employed in the reduction of ores—will be compelled to reconstruct their works, anyhow. When that time comes (if the disposition is to exercise patience) urge or compel, if necessary, the owners to move out of this valley and go where no harm can result from operation. There is a world of room in the Rush Valley section, on the line of the San Pedro railroad, between Stockton and Tintic, where smoke and fumes could be turned loose without damage and where the interests of the few settlers could be acquired for a song.

To build new works in that section while the present plants are still in operation would prevent any loss of time to the smelting companies and give them a field in which no trouble would occur in the future. The location would bring them closer to many of the mines they serve and railroad facilities from all points could be made, with little trouble, and practically no additional cost to the shipper, just as good as they are in this valley. That this argument is sound is illustrated in the fact that the International Smelting Company is now operating in a section close to the one proposed for the valley smelters and on the same line of railroad, while it is doing business with mining companies operating all over Utah and in practically all of the surrounding states, from Arizona to Montana and from Colorado to California. What the International company is doing other companies can do and should be compelled to do.

The greatest trouble in carrying out measures of public policy and civic concern is usually found in the clashing of business interests. Avarice holds sway in one quarter; fear of huge corporation power begets a cringing, weak-kneed silence in another, while politicians and administrators of public affairs usually are too busy "fence building" to work zealously for the public weal. However, there is no reason why the presumbably untrammeled press should not speak up and let the people know that a campaign for the complete eradication of the ill-health-breeding nuisance will be supported. If it is found, as it will be, that so long as the big smelters are permitted to do business at the doors of the city the trouble will continue and grow worse instead of better, then the smelters must be persuaded to move—and this will not be asking too much, nor will it work such a hardship on the smelting companies as would appear at first thought.

MEANS MUCH TO CITY.

Such a move as that here proposed would mean a tremendous growth to Salt Lake City and Salt Lake valley. The city would still remain the principal supply point to the smelter communities and the chief offices would remain here. The lands abandoned by the smelters would at once become valuable for home-building and home-making purposes and a thrifty, permanent population would quickly replace the more or less shiftless class from which a large percentage of smelter workmen is recruited. That would mean increased business for the merchants of this city, which could then be advertised as the finest residence valley in the entire western country—and the claim would hold good.

If our public officials and business men shudder at the thought of inaugurating a move that evidently must be made sooner or later, what is the matter with having the women folks of the community formulate a petition embodying measures of relief to the incoming legislature and then insist on the Salt Lake county delegation working for it? Certainly it would not be opposed by senators and assemblymen from other portions of the state.

In anticipation of the probable and only defense that may be set up against the drastic measures here suggested, it may be said that the United States and American Smelting companies have installed a system of smoke filters known as the bag house process, whereby it is claimed

that the deleterious substances contained in the smelter fumes have been entirely neutralized or eliminated. In answer to this, it is well known by every engineer, every chemist and metallurgist, as well as the farmer informed upon the subject, that the sole effect of the process has been to extract from the vaporous fumes the solid substances which, of themselves, are comparatively harmless, leaving in the air all of the more volatile sulphur and arsenic gases to mingle with and render unbearable and dangerous the otherwise comparatively harmless soot and smoke that is emitted from the furnaces of homes, business blocks factories and work shops.

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TOM LAWSON AT IT AGAIN

Are you reading Tom Lawson's articles in Everybody's, wherein he charges that the high cost of living is due to the robbery of the people by the stock gambling manipulators of Wall Street? If not, you ought to be. In the December issue he gives some history that will make a lot of wiseacres sit up and take notice and he also offers what he believes would be an effectual remedy for the evil. Incidentally he refers to the manner in which he helped the Guggenheims to unload a raft of Yukon Gold shares on the public and cleaned up $2,000,000 on the deal; how he got sand-bagged by his employes before he got through, and how later the stars of Financialdom, during the 1907 panic, begged him to get into harness and help them out of a hole; how he cleaned up another $2,000,000 on that job and how, some time later, he whisked the market for $6,000,000 in Chino. He promises to give details concerning the Chino deal when he gets around to it, and this promise will not tend to elate the manipulators who would now have you believe that the stock is worth $60 a share. Lawson is conceded—even by his enemies—to be a pretty bright fellow and on to all the tricks of the stock-gambling game, so you must not believe that he would have unloaded his Chino at prices made by himself for the occasion, if he did not know that he could not "stay in" and win—if he was not then certain that no "outsider" would ever be allowed to make money in that stock. Read what Thomas has to say and then try and figure out where you will land if you tackle Chino, Utah Copper and Ray Con., which are now being groomed for the day when the market can be forced and the public can be led into the slaughter house.

IMPORTANT RULING RESPECTING PHOSPHATES

All present owners of phosphate mining claims throughout the public domain and all those who in any way are interested in the search for, or who contemplate the purchase of phosphate deposits located upon the public lands, will feel relieved to learn that the Department of the Interior has fully passed upon the character of these deposits and pronounced them subject to disposition only under the provisions of the lode mining laws. Ever since the discovery of phosphate upon the public lands of the West there has been litigation between lode and placer claimants and in many instances this litigation has been bitterly contested and very expensive.

This decision of the Department of the Interior not only will clear up many cases within the phosphate reserve, but will act as an incentive to prospecting for further deposits upon the public domain outside of the specifically withdrawn areas. The Department's ruling, which is in the nature of instructions to the Commissioner of the General Land Office here, is dated Dec. 7, 1912, and reads as follows:

TEXT OF OPINION.

The Department is in receipt of your letter of February 19, 1912, submitting for instructions, pursuant to departmental order of June 30, 1910, the matter of mineral entry 01635, made August 31, 1909, for the Harry Lode mining claim, situated in the E. ½, Sec. 7; W. ½, Sec. 8, T. 11 N., R. 8 E., S. L. B. M., Salt Lake City, Utah.

This claim was located October 31, 1907, by M. S. Duffield, et al., the present entrymen, on account of a deposit of rock phosphate disclosed therein. Subsequently to such location and on December 9, 1908, the township wherein the claim is situated was, by departmental order of that date, withdrawn from all forms of location and disposal, subject, however, to valid existing rights. By executive order of July 1, 1910, the said departmental order of withdrawal was, insofar as it included lands described in said executive order ratified, confirmed, and continued in full force and effect; and subject to all of the provisions, limitations, exceptions and conditions contained in the act of Congress entitled "An Act to authorize the President of the United States to make withdrawals of public lands on certain cases," approved June 25, 1910, there is hereby withdrawn from settlement, location, sale or entry and reserved for classification and in aid of legislation affecting the use and disposal of the phosphate lands belonging to the United States, all those certain lands of the United States set forth and particularly described as follows, to-wit: T. 11 N., R. 8 E., Secs. 4 to 9 and 16 to 21, inclusive; Secs. 30 and 31.

You report that: "The application proceedings appear to be regular in all respects, the only question in the case being as to the patentability of the land; and, if patentable, whether as a lode claim, as applied for and entered, or under the laws pertaining to placer mining claims."

In the case of Henderson, et al., vs. Fulton (35 L. D., 652, 662), it is said: "It may well be further stated, as a proposition equally supported by the authorities, that the amount of land which may be located as a vein or lode claim and the amount which may be located as a placer claim, and the price per acre required to be paid to the Government in the two cases when patents are obtained, and the rights conferred by the respective locations and patents, and the conditions upon which such rights are held, differ so materially as to make the question whether mineral lands claimed in any given case belong to one class or to the other, a matter of importance both to the Government and to the mining claimant. And, it is also true, mineral lands of either class can not be lawfully located and patented except under the provisions of the statute applicable to such class. Veins or lodes may be located and patented only under the law applicable to veins or lodes. Deposits other than veins or lodes are subject to location and patent only under the law applicable to placer claims."

And at page 685 of the same decision, it is said: "It is apparent also that Congress had in mind and fully recognized, what experience had heretofore abundantly shown, that these two classes of mineral deposits are so different in their character and formation, and so completely separate and distinct from each other, that even when found to exist in the same superficial area, they may be located and held by different persons, and patented accordingly (Sec. 2333). This principle has been recognized and followed in both judicial and departmental decisions (Reynolds v. Iron Silver Mining Company, 116 U. S., 687, 695-7; Aurora Lode vs. Bulger Hill and Nugget Gulch Placer, 23 L. D., 95, 99-100; Daphne Lode Claim, 32 L. D., 513; Jaw Bone Lode v. Damon Placer, 54 L. D., 72)."

To the same effect also is the decision

in E. M. Palmer (38 L. D., 294). See also Clipper Mining Company v. Eli. Mining and Land Company (194 U. S., 220, 228) and Webb v. American Asphaltum Mining Company (157 Fed. Rep., 203, 206).

If, therefore, the deposit, on account of which title to the claim here in question is sought, exists therein in vein or lode formation, the area would be disposable only under the provisions of the lode mining laws. If, on the other hand, it be a placer deposit and there be no lode within the limits of the claim, the lode laws would have no application, but the land would be subject to entry and patent exclusively under the provisions of the placer mining laws.

The claim is situated in the northern part of what is known as the Crawford Mountain area. The record in this particular case does not present such a description of the deposit as would enable the Department to intelligently determine its precise character. The claim, however, is shown to adjoin, on its northerly end, the southerly end of the patented Lorine Lode mining claim, and to be laid along a southerly extension of the outcrop of the same deposit, which, in a report filed in connection with the Lorine patent proceeding, was described by the mineral surveyor, who surveyed the latter claim. This description, which is deemed by the Department to sufficiently establish the character of the deposit disclosed on this claim, is as follows: "The said deposit consists of a series of bedded veins of rock containing varying proportions of calcic phosphate. The individual veins of the series of veins vary in thickness from a few inches to ten or twelve feet. Only a portion of the veins contain rock sufficiently rich in calcic phosphate to be of commercial value, and only a portion of the veins are thick enough to be profitably mined, even when the contained proportion of calcic phosphate is sufficiently high. * * * Physically, the higher grade vein rock occurring in the veins of the Lorine lode location is hard, its color is a grayish, bluish black. It is homogeneous in appearance, and is composed of small oolitic rounded grains cemented together by an extremely thin film of calcite and silica. * * * Taken as a whole, the above mentioned series of beded veins of phosphate rock and also each of the individual or separate veins of the series lies between, is conformable to, and is bounded by walls of rock, which wall rock is generally limestone, but often is a very silicious or cherty limestone, or a soft sandstone, or a shale or quartzite."

Here follows a sectional description of the phosphate beds disclosed in the tunnel on the claim.

From the position of the hanging wall of the series of veins as exposed in the Lorine tunnel, the indications on the surface along the apex of the veins and the prominently outcropping foot wall formation west of the mouth of the Lorine tunnel, I estimate the thickness of the series of veins, taken as a whole, from the contact of the eastern-most vein of the series of veins with its hanging wall, to the contact of the western-most vein of the series with its foot wall, to be approximately 110 ft.

As shown in the above descriptions, the individual veins of the series of veins of phosphate rock which exist in the Lorine location, are separated from each other by strata of limestone, chert or shale. These separating strata vary in thickness from less than an inch to several feet. Taken as a whole, the series of veins lies between and is clearly limited and defined in extent and position by solid massive walls of hard silicious, limestone. Within the series of veins the separating strata limit and define the extent and position of the corresponding individual veins of the series and are the walls of these individual veins. The strike and dip of the veins and walls conform to each other throughout their entire extent within the Lorine lode location. I thus find that, taken separately or as a series, that is, as a whole, the veins are obviously in place between walls, have a well defined dip, and strike and are an essential part of the mountain upon which the Lorine lode location is located.

This and co-related deposits in Bear Lake county, Idaho; Uintah county, Wyoming, and Rich, Weber and Morgan counties, Utah, were in 1909 examined by Messrs. Hoyt S. Gale and Ralph W. Richards, geologists of the United States Geological Survey, the results of which examination are given in Bulletin No. 430. As described by those gentlemen, the formations and the phosphate-bearing member thereof do not differ in any substantial particular from the formations and deposit existing upon the Lorine claim described by the mineral surveyor thereof.

Sections 2320 to 2328 of the Revised Statutes make certain provisions for the locating, working, holding and purchase of mining claims "upon veins or lodes or quartz or other rock in place, bearing gold, silver, cinnabar, lead, tin, copper, or other valuable deposits." Sections 2329 to 2331 provide that claims usually called "placer," including all forms of deposit excepting veins of quartz, or other rock in place, shall be subject to entry and patent under like circumstances and conditions and upon similar proceedings, as are provided for vein or lode claims, but with wholly different provisions as to extralateral rights, area, survey, and price to be paid for the land.

If, therefore, the deposit here in question, which undoubtedly contains a valuable mineral substance, answers the description of a vein or lode of quartz or other rock in place, it is subject to disposition exclusively under the provisions of the lode land law. If not, then the placer laws alone are operative.

In the case of Iron Silver Mining Company v. Cheesman (116 U. S., 529., the Supreme Court, page 533, said: "What constitutes a lode or vein of mineral matter has been no easy thing to define. In this court no clear definition has been given. On the circuit it has often been attempted. Mr. Justice Field, in the Eureka case (4 Sawyer, 302, 311), shows that the word is not always used in the same sense by scientific works on geology and mineralogy and by those engaged in the actual working of mines."

After setting forth the court's definition in the Eureka case, the court says: "This definition has received repeated commendation in other cases, especially in Stevens v. Williams (1 McCrary 480, 488), where a shorter definition by Judge Hallett of the Colorado Circuit Court, is also approved, to-wit: 'In general, it may be said, that a lode or vein is a body of mineral or mineral body of rock, within defined boundaries, in the general mass of the mountain.'"

In Hays, et al., v. Lavagnino (53 Pac., 1029), is is held (Syllabus) that: "In practical mining, the terms 'vein' and 'lode' apply to all deposits of mineralized matter within any zone or belt of mineralized rock separated from the neighboring rock by well-defined boundaries, and the discoverer of such a deposit may locate it as a vein or lode. In this sense, these terms were employed in the several acts of Congress relating to mining location."

In Beale v. Cone (62 Pac., 948, 953), it is said: "The controlling characteristic of a vein is a continuous body of mineral-bearing rock in place, in the general mass of the surrounding formation. If it possess these requisites and carry mineral in appreciable quantities, it is a mineral-bearing vein within the meaning of the law, even though its boundaries may not have been ascertained."

In the case of the United States Mining Company v. Lawson (134 Fed. Rep., 769), which was affirmed by the Supreme Court (207 U. S., 1), it was held that a broken, altered, and mineralized zone of limestone, lying between walls of quartzite constituted a lode or vein within the meaning of the mining laws.

In Duggan v. David (28 N. W., 887), a deposit of mineralized quartzite, a formation of purely sedimentary origin,

about ten feet in thickness, inclosed between a stratum of limestone and a separate and distinct bed of quartzite, and having a dip of about 8 deg., was regarded by the court as a lode or vein within the meaning of the mining laws.

In the case of E. M. Palmer, supra, the Department has before it for determination the question as to whether a deposit of sandstone shown to carry gold, which had been located under the placer mining laws, was a lode or placer formation. The Department, in that case, at page 297, said: "From the reasoning of the authorities cited, it follows that sandrock or sedimentary sandstone formation in the general mass of the mountain-bearing gold, such as is here disclosed by the evidence, is rock in place bearing mineral and constitutes a vein or lode, within the purview of the statute, and can be located and entered only under the law applicable to lode deposits. The Department is convinced that the deposit described in the testimony in this case falls well within the category of lode deposits under the mining statutes, and that such a deposit can not lawfully be appropriated or patented under those portions of the statutes which apply to placer claims."

The mineral-bearing sedimentary deposits, held in the cases above cited to be lodes or veins within the meaning of the mining laws, were valuable on account of the metallic minerals therein contained. In Webb v. American Asphaltum Mining Company, supra, decided in 1907, it was, however, held, in substance, that the clause other valuable deposits," used in section 2320, Revised Statutes, includes non-metaliferous as well as metaliferous deposits, and hence that a deposit of asphaltum in lodes or veins in rock in place may be entered and patented under section 2320, and may not be secured by means of placer claims under section 2329, nor the act of February 11, 1897 (29 Stat., 526) regarding the entry of lands containing petroleum and other mineral oils. Citing and following this decision, the Department, in the case of Utah Onyx Development Company (38 L. D., 504), held that valuable deposits of onyx occurring in well-defined fissures, with clearly marked hanging and foot walls of limestone, are subject to appropriation only under the lode mining laws. In the earlier case of Henderson et al., v. Fulton, supra, the Department said, at page 683: "Some of the authorities hold the view that only minerals of the metallic class are within the statutes relating to veins or lodes, but the great weight of authority is the other way; and the Department is of the opinion that the latter is the better view. That the statute is broad enough to embrace minerals of the non-metallic as well as the metallic class, wherever found in rock in place, was distinctly held after careful consideration and full discussion in the case of Pacific Coast Marble Company v. Northern Pacific Railroad Company (25 L. D., 233, 241, 243). See also Lindley on Mines, Secs. 86, 323; 1 Snyder on Mines, Sec. 337)."

It is immaterial, therefore, whether a deposit bear minerals of a metallic or non-metallic nature; if a mineral deposit exist in vein or lode formation—that is to say, if it be in place in the general mass of the mountain—it is, whether the mineral it bears be metallic or non-metallic, subject to disposition only under the provisions of the lode mining laws.

From the foregoing, it is clear to the Department that a deposit of phosphate rock, such as that herein-above described, confined, as it is shown to be, between well defined boundaries, constitutes a lode or vein of mineral bearing rock in place within the general mass of the mountain, and hence is subject to disposition only under the provisions of the lode mining laws.

This location, so far as the record discloses, was made in entire good faith, and there is no suggestion of anything that might in any wise invalidate the claim, the location, and, in fact, the entry, having been made before the executive withdrawal of July 1, 1910.

In the absence of other objection, therefore, the claim will be passed to patent as located and entered.

Very respectfully,

SAMUEL ADAMS,
First Assist. Sec'y.

EXTRACTING GOLD FROM GRAVEL DEPOSITS [II.]

By AL H. MARTIN.

The hydraulic mining process is sixty years old; 1852 saw the first application of the principle, and the modern "giant" was an established reality in 1886. Since that time a few minor improvements have been made, but the device is practically the same as when Craig invented it, one years after the close of the civil war. Like the modern stamp mill, hydraulic mining first saw the light in California. Its development followed a period of evolution; its perfection was the fruit of years of practice with cruder appliances. In the gold rush to California in 1849 and 1850, miners from all corners of the world poured into the new El Dorado. Each nation contributed its favorite contrivance for the winning of the gold from the placers. The Mexican and the Chilean brought the batea—and the southeastern Americans brought the rocker. At this period the Georgians were the most skillful and enterprising of American gold miners. The hills and ravines of sunny Georgia yielded much of America's gold, and it was fitting that the gallant Southerners should play a stellar part in the mining of the treasures of a new state they had so valiantly struggled to add to the national constellation As the surface deposits became exhausted it naturally developed that more advanced methods were employed to win the auriferous wealth. The longtom followed the rocker, and in its steps treaded the sluice box. By 1852 sluice mining had advanced to the point where operations were conducted by running a stream of water on a gravel bank, washing down the waste to the pay-gravel, and then leading the auriferous material into sluices by pick and shovel. The method naturally consumed much time and costly labor, and many of the more progressive operators demanded more effective means.

FIRST HYDRAULIC MONITOR.

And necessity compelled the remedy. Two camps claim the honor as the birthplace of hydraulic mining, but to Nevada City history awards the palm. The name of the pioneer inventor has been forgotten, but his device survives. A bank of deep gravel, averaging about fifteen feet, invited operations and it was evident that more advanced methods than those prevailing must be employed to compel greatest success. The enterprising miner procured a quantity of green beef hides, of which he formed a hose with the aid of copper rivets. For the nozzle he took two pieces of wood, hollowed them out and fastened them securely with hoops of iron to the hide hose. News of the novel attempt spread fast and a crowd of interested, half-skeptical gold-diggers, were on had to witness the first trial. At the first shock of water the gravel bank commenced to crumble, and soon the mass of material was crashing down to the sluices The hydraulic monitor had been born!

About the same time the device was used near Forest Hill, Placer county, and was soon in general use throughout the foothills. The hides were soon replaced with heavy canvas, and copper shanks and nozzles used. The average hose had a diameter of six inches, with the nozzles having diameters varying

from one to three inches. As more difficult gravel was mined, and heavier streams of water were employed, the first hose was covered with a second of particularly heavy canvas, and the whole protected with heavy rope netting. This method prevailed until heavier work resulted in the employment of sheet-iron ferules to prevent the breaking of the hose.

From the first no difficulty was experienced in breaking down the gravel banks with the crushing jets of water—the problem was to construct a hose of sufficient strength to withstand the terrific strain. The question was answered by substituting seven-inch galvanized pipe for the hose, with a short piece of strong hose attached to the nozzle to provide flexibility. Then came the so-called "gooseneck," facilitating the revolution of the nozzle in a circle, and in 1866 Craig perfected the modern giant.

STAGGERING PRODUCTION FIGURES.

With hydraulic mining in full swing, California maintained a steady production of $20,000,000 to $30,000,000 per annum. From the discoveries of 1849 to 1883, California gravels yielded the stupendous total of $1,050,000,000. The zenith was reached in 1852 when $81,294,700 was produced. And several years recorded from $50,000,000 to $75,000,000, elequently testifying to the marvelous wealth of the deposits. The enactment of anti-debris legislation struck down the industry in its prime, but while the giant has passed from the majority of California districts, the state has played the greatest role in the development of one of the most effective and inexpensive mining methods ever devised for extraction of gold from auriferous deposits.

To employ the hydraulic method to best advantage, water must be plentiful, and a convenient dumping ground is imperative. It is usually requisite that large reservoirs be provided for conservation of water for the dry season, otherwise the operator will probably find his water lacking when most desired. This is particularly true of the Western states of America, where the year is divided into wet and dry seasons. Magnitude of installation depends on extent and values of ground, and the same care is required in providing equipment and arranging for the scale of operations, as pertains to other branches of mining. The engineer must be largely influenced by the status of the property and local conditions. The low operating costs and the vast quantity of material handled in a given time form two of the most important factors in favor of the method.

NOTABLE OPERATING EXAMPLES.

The most noted, and probably the largest, of the world's active hydraulic mines, is the famous La Grange, at Weaverville, in the north-western portion of California. The laws militating against hydraulic mining in California are not effective in Trinity, Siskiyou, Humboldt and Del Norte counties, as the streams drain directly into the Pacific ocean. In the central and valley sections, the streams are tributary to either the Sacramento or San Joaquin rivers, the two principal watercourses of the state. The lands lying along those rivers are generally low, and the laws against the hydraulic operators were largely enforced because of allegations that deposition of debris in the streams caused disastrous floods in the lowlands. In the counties specified the lands bordering the streams are generally high, consequently there is no danger of inundations in the rainy season As a result, hydraulic mining flourishes in these districts, particularly in Trinity and Siskiyou, with much of its primeval glory. La Grange for years has been the leading hydraulic property in the state, and the methods employed mark the culmination of the most advanced hydraulic practice.

The deposit is geologically a portion of an ancient channel formed by the Trinity river and its branches. The channel has a width of approximately one mile, and in places attains a depth of 60 feet. The bedrock is of rough, slaty structure, with a bed of sticky clay dividing it from the north belt of gray schistose rock. The gravel contains considerable rough rock and huge boulders, with a heavy deposit of cemented material occurring in the lower portion of the channel. The ground offers considerable difficulty to mining, and the ease with which the company has mastered all problems is an eminent testimonial to the efficacy of hydraulicking intelligently applied.

The water supply is developed on Stewart's Fork of the Trinity river, twenty-nine miles from the mine. Over eight miles of flume brings the water from the reservoir to the first inverted siphon. The mammoth pipe has a 4,800-foot span, with a depression of 1100 feet, and is composed of 30-inch steel pipe, with the lower portion a half-inch thick. From this siphon the water passes through a 9000-foot tunnel, two smaller siphons, a flume and a ditch, to the supply reservoir at the penstock. The maximum flow is 3400 miner's inches. Three main pipelines command the penstock and supplies water to six giants operating under 450 to 650 feet head pressure Three of these big monitors, together with one smaller, operate simultaneously. The largest pipes have 30-inch diameters, with 15 to 18-inch in-takes and discharging through nozzles ranging from five to eight inches. Guage of pipe ranges from No. 4 to No. 7. Each giant is provided with safety-clutches, to prevent accidents to operators, should the kingbolt snap and the huge head of the machine hurl into space. The pipes are also fitted with devices permitting the operator to ride the pipe and deflect the stream to any point with ease and efficiency. The safety devices were invented by Manager Pierre Bouery, and have frequently proven their value. Automatic floats regulate the reservoir discharge, consequently a uniform quantity of water is constantly delivered, whether the reservoir is nearly empty or full, regardless of pressure. Operations are carried on day and night, the property being excellently illuminated with electric lights; imprinting a striking and lasting scene on the mind of the observer as the huge streams of water sparkle and shine under the glare of the globes.

HOW THE WORK IS DONE.

The 600-foot bank is generally undercut by the jets of water and slowly crumbling, breaks down the stubborn cemented deposit with its terrible weight. Formerly blasting was resorted to for the disintegration of the cemented gravel, but this is now employed only for the breaking of mammoth boulders and the masses of cemented material that are not reduced sufficiently by the caving of the upper bank. The belts of clay are bored with an Ingersoll wood-boring machine and blasted. Derricks are used to remove the boulders, this being done while the giants are operating on some other portion of the mine. The bedrock is swept clean by the searching water, and no scraping is required.

The sluice has an approximate length of 3000 feet, with the sluice-boxes four by six feet in cross-sections, set into the bedrock. With the exception of the first seventy which have a slope of seven inches per twelve feet, the boxes are inclined to a grade of eight inches per twelve feet. Steel rails are used for lining throughout. With the exception of a few longitudinal rails in the first few boxes, designed to aid the flow of material, the rails are laid transversely. A space of five inches between rails is generally employed. Thirty transverse rails are placed in each of the 150 boxes. The powerful stream drives 1000 cubic yards of material through the sluice-way per hour, including boulders weighing up to seven tons. At times blockades form, and the operating crew break the jams with iron bars. This work is attended with considerable danger, but accidents are rare among the skilled workers. At times the jam becomes so serious that sluicing is temporarily suspended, but this is of comparatively rare occurrence.

About 1400 feet from the head of the sluice is a steel door and branch sluices,

by means of which the material is diverted to other dumping grounds. This also facilitates the rapid clearing of the sluice when desired. Manganese steel is used in the riffles, and while the rails, including attached lugs, cost about $5 for each prepared six-foot section, their long life and general fitness for the work, justifies their employment. The high freight rate forms one of the main items of expense, all materials being shipped in from Redding by teams, a distance of about thirty-five miles. The lower sluices are cleaned up frequently, but the first fifty boxes are generally attended to only three times each year.

"ANTI-HYDRAULIC" METHODS.

An interesting example of a property operated under the anti-hydraulic laws is presented by the Brandy City mines, at Brandy, Sierra county, California. The channel ranges from 200 to 600 feet wide, with a depth exceeding 200 feet. Coarse gravel overlays the bedrock, and in turn is capped by a belt of fine gravel and clay or decomposed slate. Above this is a fifty-foot belt of lava and loose surface gravel. Adits, ranging from twenty to forty feet long, are driven under the lava bed, crosscuts extended, and the material blasted. The gravel near bedrock is a cemented type and requires blasting. The numerous boulders are blasted and removed by derricks. A flow of 4000 miner's inches of water is brought to the placers from Canyon creek, a distance of ten miles. Flumes are used for this purposes. Six giants are used, two being operated together. The sluices are provided with steel riffles in the first string of boxes, but in the lower section 18-inch wooden blocks are employed. Boxes have dimensions of five by five inches. The sluices discharge the debris into a canyon, across which the restraining dam is constructed. The barrier, built of masonry and concrete, has a thickness of twenty feet and is designed to prevent the escape of any tailings to the creeks. From the main line of sluices, a branch flume conducts the gravel to the barrier, constantly adding to its strength and height. By arrangement of the flume the gravel is regularly piled higer, and a compact rock wall thus provided. The greatest care is requisite in construction and maintenance of these dams, as the escape of even small percentages of debris is a direct violation of the regulations, and means the immediate closing of the property.

Before a property can be worked under the anti-debris laws, it is necessary that permission be solicited of the California Debris Commission, and due notice of the application is advertised and all protestants given an opportunity to record their disapproval. Barriers must always be of concrete or masonry, and pass the appoval of the proper officials. Several companies have literally complied with regulations, only to have their mines closed after a short productive period because of escape of small quantities of foreign matter with the water. The building of restraining dams forms a costly expense item, and the uncertainty of future operations militates heavily against the widespread application of the practice in affected districts. Formerly barriers of timber and brushwood were permitted, but this method later fell into disfavor with the anti-debris interests, and its use was prohibited.

As prevails at the La Grange mine, the Brandy City properties are electrically illuminated and operations are conducted day and night, provided sufficient water is available. Methods of operations are similar, and the two illustrations here cited give a good idea of the hydraulic mining principles as universally applied. When natural conditions are favorable the practice has many features to recommend it, but the restrictions fencing it round in sections dominated by anti-debris elements add so many elements of uncertainty, that the ground must be particularly attractive to justify the heavy initial expense, with a possibility that work will be prohibited before the initial clean-up can be made. Permission to operate does not imply that work cannot be stopped should excuse present. Numerous California operators have learned this bitter truth from sad experience, and the same lesson has not been ignored in other fields similarly affected. In hydraulic mining the disposition of tailings often claims almost the same importance as the fume problem exacts from copper mining companies, and it is this factor that has banished the giant from California districts where the wealth of placer deposits still warrant zealous attention.

MONITOR-STACKING OF TAILINGS.

Occupying as it does such an important position, the disposal of the tailings forms a stellar link in the operation of the enterprise. Aside from the laws militating against him, the operator is often confronted with natural conditions of a complex character. The deposit may be situated at such a low point that the tailings must be elevated. Or, the dumping grounds may be so limited that the material cannot be stored in the ordinary way. In some of the California fields the elevator platform is employed. As the gravel giants tear down the banks, one or two other monitors drive the tailings up an inclined platform and the debris is dropped over the rear end. By running out braced timbers the length of the platform is constantly extended and the tailings easily piled. The objection to this method lies in the unwieldly nature of the device which must be moved from point to point as work progresses, involving expenditures of labor and time. The initial cost of such an arrangement, while comparatively small, is also a factor against its employment. But it has proven efficient in districts where the escape of foreign matter to the streams involved no consequence.

An effective method employed by some operators, where dumping facilities are restricted, but water is abundant, is stacking direct with giants. The mining giants are employed as usual, and at the discharge end of the sluiceway are stationed two or three monitors, their streams directed at right angles to the tailing issuing from the boxes. The heavier gravel is forced aside and gradually grows into piles resembling the tailings built up by the stacker of gold dredges. As the pile develops the monitor is gradually raised, and the succeeding gravel carried to top of pile. The giant is then lowered and another charge of tailings driven to the top. In this way all the coarse gravel is piled with a minimum of space consumed. The finer material is carried down the creek. In this method a large quantity of water is constantly required, and the fact that only the coarse material is prevented from flowing into creeks, precludes its use in districts governed by anti-hydraulic laws. But where conditions favor its employment, this process has much to recommend it.

It has been suggested that pumps might be employed to gather up the fine material and deposit it in restraining reservoirs, much as hydraulic dams are constructed in engineering projects. This method involves the hydraulicking of the banks in usual manner, with centrifugal pumps gathering up the mud and water and elevating it to desired points. This is the practice employed in the building of the Gratun dam on the Panama canal, and the San Fernando dam on the Los Angeles aqueduct, as well as numerous smaller enterprises of similar character. Four cubic yards of water are usually employed to each cubic yard of earth, and after depositing the material the water is returned for fresh duty.

To operate this system in conjunction with mining giants, a good supply of water is requisite, but with this feature favoring the method seems to offer some promise to companies prevented from operating because of escape of debris to navigable streams It is the fine material that has caused the trouble for hydraulic operators in practically every instance, as the coarse gravel is impounded and retained without difficulty. The efficiency of the process for the building of barriers to hold in leash billions of gallons of

water, indicates it would be likewise efficacious in preventing escape of foreign matter to navigable streams.

The expense of installation would form an important point for the engineer's consideration, as the suggested system demands the employment of large pumps, in addition to a supply system for the giants, pumps and gravity way for the return of water. At the San Fernando dam 200 to 250 cubic yards of material are deposited every hour with 300 miner's inches of water consumed per day, including the amount supplied to the giants. The water from the giants washes down the material and the whole is gathered up by pumps and the solid matter placed at desired points. The released water descends by gravity to the pipes delivering to giants, and the same stream is thus used over and over. In this way the water is conserved to the utmost point, and the cost of operation is largely cut down. The mode of operation is largely automatic, and it seems that this method might be practically employed in some instances, particularly where the escape of fine material is the principal factor militating against operations.

HYDRAULIC MINING FLOURISHES.

The present decade finds hydraulic mining flourishing most extensively in Alaska, Yukon Territory, British Columbia and favorable districts of California, Oregon and one or two other fields. In every instance a good supply of water is obtainable the greater portion of the year, while natural conditions have favored the prevalence of the practice. In numerous fields, however, where the giant was formerly deemed supreme, the gold dredge has usurped its throne, and this mode of mining is slowly ousting the monitor from some of its greatest strongholds. But dredge mining also has its limitations, and there are fields where the giant will always be operated as long as the placers contain sufficient reward.

It is one of the interesting possibilities of the future that hydraulic mining will be revived in the California districts lying along the foothills of the Sierra Nevada mountains. Engineers have long pointed out the feasibility of this, if the various owners would form a powerful syndicate for the deposition of the tailings on the waste and tule lands in the lower portion of the valley of the Sacramento river. This would eliminate the objections to hydraulicking in the vast majority of cases, and would also redeem thousands of acres of present worthless lowlands. The plan involves tremendous expenditures, but the end sought is declared by eminent engineers to justify the means.

HANDLING ACETYLENE

Owing to some recent accidents with acetylene burners, the French Minister of Commerce has submitted to a commission the question of precautions to be taken with the cylinders containing compressed gases (Journal du Four Electrique, Nov. 1, 1912). The following are the rules laid down: The cylinder containing compressed gases for autogenous welding, or for cutting metals, should not be used in workshops where there are floors above containing people. Before being placed in service each bottle should be placed in a ditch of which the sides are protected by battens of wood, and only the neck of the bottle should appear above the surface of the ground. The cylinder should be placed at least 5 m. from any fire. Each cylinder should bear legibly upon it the date of being placed in service, and the pressure to which it was submitted at the last test, and the date of the test. It is forbidden to employ any lubricating greases for greasing the valve, except glycerin or soapy water. It is equally forbidden to employ any heat to make it easier to open the valve, even though this opening proves to be difficult. In using oxyhydrogen gas for soldering there should always be a mixer between the bottles and the flame. There should be a distance of at least 3 m. between the neck of the flask and the neighborhood where the flame is to be used.

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TEMPERATURE OF FLAMES

According to a lecture delivered by J. A. Harker, at the Royal Institution, London, the accompanying table gives the temperatures obtained in various forms of commercial apparatus:

Working Temperatures.	Deg. C.
Bunsen burner	1100—1350
Meker burner	1450—1500
Gasoline blast lamp	1500—1600
Large gas furnaces	1600—1800
Oxyhydrogen flame	about 2000
Oxyacetylene flame	about 2400
Thermit	about 2500
Electric arc	about 3500
Electric arc (under pressure)	about 3600
Sun	about 5500

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Sulphuric acid when employed for the hardening of the cutting edge of drills should be poured to the depth of about an eighth of an inch in some vessel. The point of the drill is heated to a dull cherry red and dipped in the acid to that depth. This makes the point extremely hard while the rest remains soft. If the point breaks, reharden with a little less acid in the vessel. After hardening a drill in this manner, wipe off the acid, as if allowed to remain will destroy the cutting edge.

Compressed air that is to be used for aerating the sand or slime, or in agitating the pulp is purified by filtration before use at many cyanide plants. Several types of filters are used; at the Homestake plants the air is passed through a filter press made up of several cells similar in all respects to the cells of the Merrill presses used in the treatment of slime. Cylinder oil or the products of its combustion or decomposition, which are introduced into the air in the cylinders of the compressors, are the impurities that should be removed as completely as possible before the air is used for agitating. The apparatus at the Alaska Treadwell has a further advantage in that carbonic acid is also removed by caustic soda or milk of lime. The removal of this acid is accompanied by a decrease in the consumption of cyanide, for it is a well known fact that carbonic acid decomposes potassium and sodium cyanides, and even in the presence of an abundance of protective alkali some decomposition by this acid may take place.

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In the old mining days, writes an engineer, timbermen had to come to surface and select their own timber and ride down in the skip with it. In one of the Copper Country mines there were two gangs of timbermen, one Cornish, the other German, and a great deal of rivalry existed. One day while the "Cousins" were sending down timber, two of the Germans rode down with the first load and at the second level the rope broke. A spectator seeing something was wrong called to the "Cousins" at the collar of the shaft: "What's wrong?" "Skip gone down without the string to it." "Any one in the skip?" "Yes, planks, wedges and two Dutchmen—planks and wedges belong to we."—Engineering and Mining Journal.

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There has just been put out of service at the Dolcoath mine in Cornwall an engine which was erected in the year 1815. During all the intervening period it has been working faithfully and well and is a tribute alike to Cornish mechanical genius and workmanship. That it has now ceased to perform its functions is due in no sense to lack of duty or weariness in well-doing, but simply to the circumstance that the old at Dolcoath is giving place to the new.

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High voltage machine terminals should have insulating covers or grounded metal covers. Unauthorized persons must not enter stations or transformer rooms. Fire buckets, filled with clean dry sand should be kept in these places for prompt use in extinguishing fires.

RAY CONSOLIDATED PROPERTIES; DESCRIPTION AND COMMENT

By JAS. O. CLIFFORD.*

The mining properties of the Ray Consolidated Copper company are at Ray, Pinal county, Arizona, about twenty miles west of the Globe district. The Ray & Gila Valley railway, a standard guage line owned by the company, connects Ray with the Arizona Eastern railway at Ray Junction, a station on the latter road about six miles south of the mines.

View of Ray Con. Mine at No. 1 Shaft.

The area of mineral land controlled by the Ray Consolidated Copper company in the Ray mining district is, approximately, 2,500 acres, nearly all of which is held under patent.

GEOLOGY OF DISTRICT.

The Ray, or Mineral Creek mining district, is an intermountain basin having an average elevation of approximately 2,300 feet, surrounded by peaks 3,500 to 6,500 feet high.

Geologically the Ray "disseminated" copper deposits differ from the several so-called "porphyries"—excepting the Miami-Inspiration properties, of which they are an exact counterpart—and, therefore, a general outline of the principal features of the district is herewith given:

The rocks of the district include diabase, granite, dacite, schists, quartzites, limestones, and conglomerate. The diabase is the oldest rock in the district, and apparently is of the same age as the diabase found at Globe and Miami. The freshly broken rock is dark-gray to black in color, and clearly shows feldspar crystals, and considerable augite and magnetite. The diabase occurs abundantly in the quartzite area a few miles east of Ray, where it has intruded along the shale beds, although also breaking irregularly across all horizons in the district. Three large diabase dikes occur in the mineralized area of Ray; one extending from the Ray Con. offices to the summit of Ray mountain, having a dip of 50 deg W.; a second runs west along a fault plane, and a third shows at the southeast end of Ray mountain. These dikes vary from two to 100 feet wide. The rock evidences decomposition by acid waters with attendant impregnation of small quartz veinlets. Generally the rock carries chalcopyrite and pyrite, and in some instances the dikes were worked as veins, the material mined having averaged as high as 10% copper. The diabase occuring in the Ray mines will average throughout from 0.50 to 1.0% copper. None of the dikes are, however, well exposed on the surface.

The granite at Ray occurs as intrusive bodies that are off-shoots of the great mass exposed to the west and southwest, and doubtless underlying the entire district at considerable depth. The rock exposed in the Ray Central and Ray Con. mines apparently cuts off the diabase dikes. The rock is an ore-carrier in these intrusive tongues. East of Mineral Creek there is an extensive mass of granite exposed which has cut through the quartzite and the schist. This mass shows comparatively little alteration, and is not an ore-carrier.

The dacite covers a large part of the district east of Mineral creek, and occurs as a capping on mountains to the north and west of it. In color it varies from pink to dark-lavender. This is the prevailing rock along the east side of Mineral creek, and forms high bluffs along the eastern mountain base. The greater part of the lower hill country between

Ray Consolidated Concentrator at Hayden.

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the creek and the mountains eastward is covered by thinly-bedded dacite tuffs, the rocks varying in color from white, fine-grained sandstones, to coarse breccia made of minute particles of pumice and volcanic ashes, laid down on nearly a level surface. In their undisturbed condition they were flat and overlaid faulted and folded rocks, as may be seen for several miles up Devil's canyon en route to the Gibson mine at Bellevue, and similarly on the mountains to the north and west of Ray.

The schists are part of the Pinal schist series, and the main mineralized belt is formed of these rocks, although their original character has been altered by mineralization. These and the quartzites are cut by diabase and the granite hereinbefore mentioned. The entire series were once apparently covered by dacite, either in the form of flows, or as tuffs.

The schists, when not mineralized, consist of a variety of more or less thinly foliated rocks, varying from hard, dense, quartz-schists, to soft, and lustrous, gray mica-schists. Outside of the sharply-defined mineralized belt, they are unmistakable in character. In the mineralized area it is silicified, reddened by iron oxide, mashed and re-cemented by faulting, so that close inspection is required to recognize the true character of the rock.

The fresh, unaltered rock, varies from gray to almost black; the altered schist from lavender to red and brown. In many parts of the mineralized area it is earthy, and in places consists almost entirely of iron. It is an altered sedimentary rock.

The quartzites, interbedded with red shales, form a series several hundred feet thick. The rock varies from a typical quartzite, a dense crystalline rock, to a fine, white, sugary quartz, resembling an acid granite. In a few instances it is found grading into a coarse conglomerate or well-shaped pebbles. This quartzite occurs east of the Mineral creek, and is not present in the area immediately adjacent to the ore-bodies west of Mineral creek. In the quartzite area east of the creek the rock is cracked and crushed at many points, and substantially impregnated by copper ore, especially close to faults bringing it against diabase.

Sketch Map of the Ray District.

The limestones occur in the mountains east of Mineral creek, and are found inclined as the crest of the ranges, and lying conformably on the quartzite series. This limestone belt is of no consequence when considering the Ray copper deposits, and is noteworthy only for the occurrence of lead deposits therein.

The conglomerate (Gila) covers an extensive area to the south of Ray. It is a coarse to fine conglomerate, weathering into steep bluffs and towering pinnacles, and was formed later than the ore-bodies.

STRUCTURAL RELATIONS.

The district contains two distinct, sharply-defined, mineralized divisions, separated by Mineral creek. The western division is the Ray copper zone in which the great deposits of disseminated copper ore have been found, and is about one-half mile wide and two miles long, running in a northwesterly direction from Mineral creek. The eastern division is not so well defined, and the area in which discoveries of commercial ore have been found is comparatively small, although the area has not been as thoroughly, and as systematically, prospected as in the case of the Ray area.

The Ray ore belt consists of an irregular group of rough-surfaced, red-stained hills, trending from Ray mountain northwest to the New Year group, where the mineralized area stops abruptly near the New Year claim. The area is limited at the south by a line of distributed displacement. On the north its exact boundary has not been determined, although it is known to extend beyond Sharkey canyon. Mineral creek defines its eastern limit, so far as present intensive development is concerned.

As will be noted from a review of the foregoing paragraphs, but three of the rock series—diabase, granite, and the schists—are present in the immediate geological horizon of the Ray copper deposits, although dacite is present in the eastern horizon (commonly termed the Arizona-Hercules), the principal fault of the district, known as Mineral Creek gorge, being the acknowledged line of demarcation between the western and eastern areas.

The granite, which borders, and in places intrudes the schist, probably underlies the entire belt. Apparently it cuts off and replaces diabase in places, especially as in the case of some of the dikes exposed in the mines, suggesting a possible mineralization from the granitic magma which occurs as off-shoots, or tongues, from the underlying mass intruding the schist series. The intrusive granite is in all instances mineralized.

The diabase occurs as intrusive dikes, breaking irregularly across all horizons. It not only cuts the schist series, but has extended, as in the instance referred to in an earlier paragraph where mention was made of its breaking through the quartzite occuring in the eastern division of the horizon, still father into the younger rocks. However, in the Ray Con. area several extensive diabase dikes have been located by means of underground development which do not continue upward through the schists, for the reason set forth in the preceding paragraph.

The Ray Con. deposit consists of highly altered, silicified, reddened schist, sheared and crushed, and mineralized with copper glance and pyrite along joint planes; thin veinlets of quartz, and a net-work of tiny fractures, with impregnation of the rock alongside of the fracture by specks of chalcocite. The capping of the same schist has been thoroughly oxidized to a depth ranging from 75 to 300 feet, and this part is generally barren and leached near the surface, though it contains in part seams of rich oxidized ore, and shades into disseminated ore in depth. Below this capping of oxidized material is the ore-body proper, constituting the zone of secondary enrichment. Here the copper occurs principally as chalcocite, associated with pyrite, and in some instances (as in the Ray Central properties) native copper, and chalcopyrite.

As a rule there is a sharp definition between the zone of oxidized ore and that of sulphides, but tongues of oxidiation extend downward into chalcocite ore.

Beneath the zone of secondary enrichment lies the zone of primary sulphides. The passage is gradual, but occurs within a distance ranging from 25 to 75 feet, with various stages of secondary enrichment in this distance. The primary ore

consists of pyrite, with accessory chalcopyrite, the primary schist ore carrying less than 1% copper, while the diabase will generally average 1.20 to 1.35% copper.

Concerning the eastern, or Arizona-Hercules, area, little can be said in other than a general way, as there has not been sufficient exploratory work performed to merit the attention given the Ray area. This part of the district is entirely different from the western, or Ray zone. It is less sharply defined, and the area within which discoveries of copper ores of commercial grade have been made is small. It consists, essentially of dacite, and dacitic tuffs, forming great tilted blocks between its western boundary, Mineral creek, and the mountains to the east. The copper ores occur in fault-planes, and local impregnations, usually adjacent to diabase masses. In other words, the ore occurs in vein-like impregnations of crushed rock, in or adjacent to faults. In extent this area of the western division is the exact counterpart of the Ray Con. division, being about one and one-half miles wide by two miles long.

The principal feature of the Mineral creek basin is the strong, well-defined fault, running down Mineral creek from the north end, through the town of Ray, and beneath the Gila conglomerate to the south. It is the boundary between the developed area of the Ray Con. property on the west, and the practically undeveloped area of the Arizona-Hercules on the east. Consequently, in view of the marked economic importance of its relation to the two divisions of the district it is worthy of more than passing attention.

This great fault and its parallel sympathetic fractures has, apparently, thrown down the country east of the creek so that the dacitic tuff beds and quartzites once continuous across the valley, are at the creek level on the east side of the fault, while west of the fault the decite and quartzite that once overlaid the schist have been entirely removed. This condition suggests that the eastern area has been thrown down, assuming the western area to have remained in situ. On the contrary, however, it is, perhaps, more reasonable to assume the western area to have been raised, relatively to the eastern division. This is best illustrated by the continuity of the dacitic beds for many miles up Devil's canyon. Therefore, if the secondary enrichment, making ore-bodies of commercial grade, is earlier than the dacite, the area east of Mineral creek is valuable; but, if enrichment is later, the land has no great value for its contained mineral deposits.

ORE GENESIS.

The primary mineralization consists in an alteration of the rocks of all kinds, the primary ore being pyrite with accessory chalcopyrite. The low-grade workable ore-bodies of the district are all secondary reconcentrations of copper derived from lean pyritic material, and their occurence is governed by fault movements occasioning rock fracturing, crushing and brecciation. The primary mineralization was effected by heated gases and vapors emanating from the intrusive diabase. This mineralization by the diabase is apparent in both the eastern and western areas of Mineral creek. The mother rock, diabase, averages throughout the entire area less than 1% copper, but in many instances has been worked as veins on account of its relatively high-grade copper content. The mineralization of the granitic off-shoots or tongues, occurring in the schist in the Ray Con. mines is due to the same causes that formed the workable ore-bodies in the altered schists, viz., the resultant reconcentration of the primary mineralization in the upper zones of the schist area by its oxidation and subsequent deposition at the present horizon, replacing the pyrite particles of the unoxidized zone by glance. The concentration of the copper mineral has been carried on wholly within the schist area. At the contact of diabase with either schist, quartzite or dacite, profound alteration of both rocks occurs with the formation of rich ore. Throughout the district the presence of diabase is generally accompanied by copper. In view of this circumstance it is not unreasonable to believe that the diabase forming a contact with schist and dacite along the Mineral creek fault will be productive of large ore-bodies at a lower horizon. The intrusive granite of the district seems to have played no important part in the matter of ore deposition.

PROSPECTING AND DEVELOPMENT.

The method of prospecting the Ray ore-deposit is the same as that used in other districts, viz., churn-drilling the area in 200 foot sections, and by underground development in the older mines formerly worked for their high-grade ore. As the drilling development now stands the total area prospected covers approximately 300 acres. The average depth of the drill holes is 420 feet, showing an average thickness of 252 feet overburden, and 101 feet of ore. The tonnage calculated within the boundaries of the original Ray Con. property is 77,314,470 tons, averaging 2.17% copper. Of this quantity 65,000,000 tons, having an average of 2.16% copper is classed as fully developed, the remainder having an average of 2.23% copper and being classed as partly developed. Of the total tonnage of ore about 35,000,000 tons occurs in the vicinity of No. 1 shaft, the remainder lying in the west section. The acquisition of the Ray Central property by the Ray Con. gave the latter a property which, in comparison with its own, is superior in relative tonnage of ore developed, and average copper content thereof. While the Ray Central deposit is similar to the Ray deposit (of which it forms a part) it contains an unusually high-grade solid block of copper ore, aside from its tonnage of low-grade ore. There is fully developed in the Ray Central group about 8,000,000 tons of ore averaging 2.35% copper, and a solid block of ground containing approximately 1,000,000 tons averaging 5.93% copper. The probability of increasing the ore tonnage (both high and low-grade ores) is encouraging, and should, at least, develop 40% of the present tonnage.

Underground development continues in the matter of sinking the Ray Central main shaft which is now at the 700 foot level and in very good ore—necessary cross-cuts, and so forth, largely forming a part of the development in this property at the lower levels.

MINING ORE.

The Ray ore-body has its longitudinal axis running northwest from the Mineral creek fault. The capping is not uniform in thickness, averaging about 250 feet in the east section and 350 feet in the west section, the ore-body being 120 feet and 180 feet thick, respectively.

There are three main working shafts; two serving the Ray Con. mines proper, and a third caring for the Ray Central group. The shafts are located on the east side of the ore-body near the railway along Mineral creek. The collars of the shafts are approximately 50 feet above the railway grade, thereby affording facilities for expeditiously and economically handling the ore.

A series of double-track main haulage drifts are provided from the shafts to the ore-bodies that are to be moved. From these haulage drifts extraction drifts are run fifty feet apart to undercut the ore-body at the levels where mining is to be carried on. Chutes are raised twenty-five feet apart on both sides of the extraction drifts at sufficient angle to make the openings large and funnel-shape where they reach the bottom of the stopes, making the chutes approximately twenty-five feet apart over the entire area to be mined. Narrow stopes crossing over the tops of the extraction drifts at right angles are raised from a point twenty-five feet above the drift, and these are carried to the capping overhead, leaving pillars between them.

The stopes are long rooms cutting clear across the ore-body, and having

widths varying in proportion to the ground in which they are being cut. For example, the stopes may be 20 to 30 ft. wide, with pillars between them covering the remainder of the distance, the respective widths of stopes and pillars depending upon the stability of the ground; ordinarily, however, they are 25-ft. each, (leaving an equal pillar between the stopes), thereby corresponding with the chutes. As the stopes are raised, just sufficient ore is taken from them to make room for the miners and drills to work when standing on the broken ore. When the capping is reached work is discontinued and the crew moved to other stopes.

Raises with small cross-drifts penetrate the pillars and afford access to the stopes on either side, and, when sufficient ground has been developed, the pillars are weakened by starting their bases. Later the remaining legs of the pillars are undercut, allowing them to settle, thereby permitting the surface capping to settle down quietly to the level of the broken ore in the stopes. The ore contained in pillars crumbles in the process of the settling of the capping and is drawn out through chutes into the extraction drifts in the same manner that the broken ore in the stopes is withdrawn. The capping is allowed to settle quickest at the farthest point from the main haulage-drift, and the ore is mined in such a way as to permit the surface capping to settle down gradually. Practically no timber is used in the stopes.

MINE EQUIPMENT.

All mechanical equipment at the mine is electrically operated. Power therefor is transmitted from the central power plant at Hayden by a twenty-mile transmission line at 45,000 volts, and is transformed at the sub-stations to 440-volts.

The power plant at Ray includes two 3,000-cu. ft., and one 6,000-cu. ft. compressors (Nordberg), operated by induction motors through rope drive.

The main hoists are Wellman-Seaver-Morgan machines, rope-driven by 350-h.p. motors, the hoisting speed being 300-ft. per minute. These hoists handle 12-ton skips, in balance, and have a capacity of 9,000 tons per diem when hoisting from 300 feet.

The ore is handled underground by trains of five-ton steel ore-cars, operated by electric motors. The underground trains are handled in units of nine to twelve cars to each motor. These are backed into the extraction drifts where the ore is drawn into the cars from chutes. The ore is then taken to the shaft through the haulage drift, and the cars in units of three placed in a tipple emptying them into a 550-ton concrete pocket alongside of the shaft, from which the ore is discharged into the skips.

The skips on reaching the surface dump automatically into steel receiving bins alongside the head-frames. From the receiving bins the ore passes over two 8 in. x12 ft. grizzlies having 4-in. spaceing, the undersize passing over two 4x10 ft. grizzlies having 2-in. spacing, and the oversize going through two No. 8 gyratory crushers, the crushed material from the gyratories also passing over the two 4x10 ft. grizzlies. The undersize from the secondary grizzlies is discharged onto the belt conveyor serving the coarse-ore bins. The oversize from the secondary grizzlies is discharged into a bucket conveyor and elevated to two Garfield 72-in. rolls. The material after passing through the rolls, which reduce to pass a 1½ to 2-in. ring, passes over a third 3x6 ft. grizzly, the undersize from which is discharged to the belt conveyor above mentioned, and the oversize returned to the elevator pit. The crushed ore is distributed to the coarse-ore storage bins on the railroad, the bins having a capacity of 25,000 tons of ore. The ore is automatically sampled before entering the bins, from which place it is drawn into steel hopper-bottom cars for transportation to the mill at Hayden.

Shaft No. 2, about three-fourths of a mile northwest along the strike of the ore-body is equipped the same as shaft No. 1 in both surface and underground equipment. Shaft No. 3, serving the Ray Central mine, is about one-fourth the capacity of the two others, as it is intended primarily to handle only the high grade product from the Ray Central block of high-grade ore.

Main shafts Nos 1 and 2 are equipped with 30-deg. inclined shafts with separate electrically-operated hoists, and are provided with stairways for the use of miners, and skipways upon which is handled five-ton skips for the removal of waste, and for the handling of material into the mine.

GENERAL REMARKS.

The ore from the zones of enrichment (usually adjacent to or not very far removed from the intrusive diabase), is of comparatively high-grade, shading off to the lower grade material in the disseminated zone. While the average copper content of the Ray Con. deposit is stated as 2.16%, it should be borne in mind that, in the areas immediately underlying the oxidized capping, the average grade of ore is materially reduced, so that in many instances the company is compelled to mine and treat ore often-times averaging as low as 1.6%. However, in part, this deficiency in average grade of the large tonnage of ore mined is offset by the tonnage of high-grade ore produced from the enriched zones of the deposit, so that, while the general average copper content is apparently low, it is in fact, largely overcome by the production of higher grade material, thereby tending to increase the average copper content of the product mined and shipped from the entire area. This is clearly illustrated by the present practice at Ray where the stock pile of the Ray Central property (averaging from 2.51% to 6.09%—and sometimes higher), together with other high-grade material at present being mined from the 400-ft. level of the latter mines, are being shipped to the mill for treatment.

Further, it is the intention of the management to immediately extract the higher grade ore deposit of the Ray Central group of properties at the earliest possible moment, and every effort is being put forth to insure an early completion of the work now under way which will afford a means of maintaining a normal average of extraction from 2.16% and less, copper ore.

HAYDEN CONCENTRATOR.

The Ray Consolidated concentrator is located at Hayden, Ariz., about twenty-one miles southeast of Ray. At this point, and immediately adjoining the concentrator, is the Hayden smeltery of the American Smelting & Refining Company.

The central power plant of the company is located at Hayden and supplies the mining, milling, and smelting properties at Ray and Hayden with electric power.

Steam is supplied, in part, by fourteen Heine water-tube boilers of 513 rated h.p. each, equipped with Foster super-heaters. The feed water is delivered by four compound Blake pumps through Foster feed-water heaters. The water from the condensing system is pumped to "Ray" type, cooling-towers. Circulating water is handled by a Nordberg, triple-expansion, pumping-engine.

The four engines installed are horizontal, four-cylinder, triple-expansion, Corliss engines, with 28-in. high-pressure, 52-in. intermediate, and two 54-in. low-pressure cylinders, all having a common stroke of 48-ins. The full-load rating of each engine is 2650 h.p. when receiving steam at 175 lbs. guage pressure, and 75-deg. superheat, and operating at 100 revolutions per minute. To each engine there is direct connected a three-phase, 60-cycle, 6600-volt generator, excited at 120-volts from a 60 k.w. direct-current, engine-driven, generator. These units were built and installed by the Allis-Chalmers Company.

In the valley of the Gila river, approximately a mile from the reduction works, is situated the pumping plant. This plant consists of three wells, each 20 ft. diameter by 40 ft. deep, served by one each 16x18 Aldrich quintiplex pump, directly geared to 350 h.p. induction mo-

tors. The water is pumped to the 10,000,000 gallon reservoir above the concentrator through a 26-in. wooden pipe-line constructed to withstand a head of 280 feet. The combined capacity of the three Aldrich pumps mentioned is 12,000 gallons per minute.

MILL AND MILLING METHODS.

The concentrator is divided into eight units, all of the same general type. It is almost a duplicate of the Utah Copper Company's Arthur plant. A brief outline of the mill follows:

The coarsely-crushed ore from the mines enters the building on a trestle at a point which permits of its being dumped into receiving bins. These bins are of steel on re-inforced concrete foundations, and have a capacity of 25,000 tons.

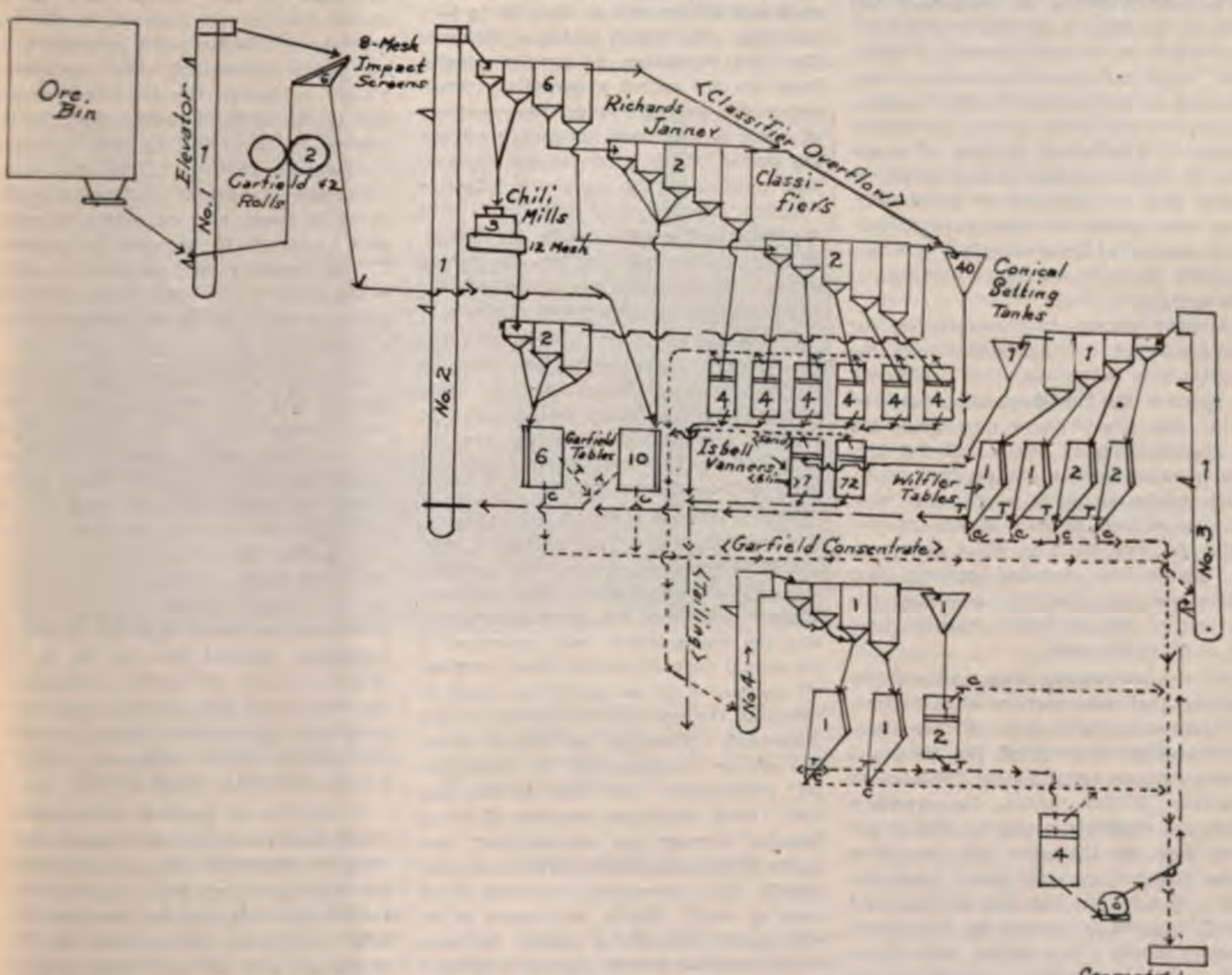
From the ore bins the ore is fed to No. 1 bucket elevator by a caterpillar ore-feeder and belt-conveyor, the ore being raised to the top of the elevator and passed over a set of six 8-mesh impact-screens, the undersize from which goes to the first ten double-deck Garfield tables, and the undersize passing through two sets of 16x42 in. Garfield rolls crushing to as small mesh as possible commensurate with the ore tonnage handled. From the Garfield rolls the crushed material is returned to No. 1 elevator pit.

The No. 2 elevator handles the tailing of the Garfield and Wilfley tables, and discharges same into six 4-spigot, Richards-Janney primary classifiers, the two first spigots of which discharge into three 6-ft. Chilian mills. The third spigots of the primary classifiers discharge into one Richards-Janney 5-spigot secondary classifier, the fourth spigots of the primary classifiers discharging into another Richards-Janney 5-spigot classifier. The third-secondary classifier distributes the product of its first four spigots to the first ten Garfield tables; the fifth spigot of the fourth-secondary distributing to twenty-four Isbell sand-vanners, each respective spigot serving an individual group of four vanners.

The rough concentrate from the Garfield tables is elevated by No. 3 elevator to a 4-spigot Richards-Janney classifier (commonly termed the "Garfield" classifier), the first spigot of which delivers its product to the first two Wilfley tables; the second spigot to the next two Wilfleys, and spigots three and four to individual Wilfley tables.

The Chilian mill product, reduced to pass 12-mesh, is discharged into two Richards-Janney 3-spigot "mill" classifiers. These classifiers deliver an unclassified pulp to six double-deck Garfield tables.

The overflow from the primary, secondary, and "mill" classifiers goes to forty Callow dewatering tanks, the thickened pulp from which is distributed to 72 Isbell slime vanners. The "Garfield" classifier overflow empties into one Callow tank, the thickened pulp from which is treated on an Isbell, or, in some instances, a Johnson suspended type, slime vanner.



Flow Sheet of Ray Con. Mill at Hayden.

The diagrammatic flow-sheet given herewith clearly outlines the milling practice. The small numerals noted in the body of the drawing merely indicate the number of that particular machine in the mill unit. For example, the numeral "3" within the figure representing a Chilian mill, indicates that there

are three mills to each unit; the numeral "40" within the figure, representing settling tanks indicates there are forty tanks, and so forth.

Two notable additions to the ore-dressing practice have been made within the past few months. The first considers the classifying of the Garfield table concentrate in a Richards-Janney 4-spigot classifier, and the distribution of the classified pulp from each respective spigot to separate groups of Wilfley tables, the overflow from the classifier discharging into one settling tank, the thickened pulp from which is treated on an Isbell, or Johnson, slime vanner. This classifying of the Garfield table concentrate merely serves to complicate the practice creating a secondary closed-circuit which is, in turn, merely a makeshift with no special advantage over treating an unclassified Garfield concentrate on the Wilfleys, as was the former practice. The added expense of operation of this particular improvement, together with its metallurgical inefficiency, does not justify its maintenance, only as a means of increasing the tonnage handled per unit, in which instance it has a place.

Another recent improvement to the equipment of the concentrator is the "concentrate re-treating plant" which will be noted in the flow-sheet cut given herewith. But two of these new plants are at present installed in the mill, but it is the intention of the management to install similar plants in every other unit, making a total of four in the present building. The units in which the treating plants are installed replace four slime vanners, thereby reducing the number of that particular machine from 72 to 68 to the unit.

All the concentrate from the mill, excepting that produced by the Wilfleys, is elevated to a 4-spigot Richards-Janney classifier from which the third and fourth spigots respectively discharge to separate Wilfley tables, the overflow from the classifier emptying into a settling tank, the thickened pulp therefrom being treated on two Isbell sand-vanners. The tailing from the Wilfleys and Isbell vanners is treated on four Isbell slime vanners. The tailing from these last mentioned vanners is returned to the No. 3, or Garfield, elevator and after classification are returned to the first six Wilfleys tables, eventually passing out as refined concentrate, or as tailing from the vanner group.

PERTINENT COMMENT.

At present but six of the eight units of the concentrator are in operation; the two others are, however, practically completed, and could, if desired, be placed in commission on short notice, but the mines are not yet prepared to yield the large tonnage required to maintain the mill rating for a considerable interval of time, consequently no effort is being made to place them in operation.

Each unit of the concentrator is designed to treat 1000 tons of ore every twenty-four hours, and, under normal conditions, (that is, operating on a tonnage basis of 800 to 1000 tons per diem), effects a very satisfactory recovery of the copper contained in the better grade ores mined from the enriched ore-bodies at Ray, considering the general mill plan.

However, the customary practice at Hayden, as at the other plants controlled by the same management, is to operate each unit of the mill at from 30 to 60% overload. The result of this practice is that the extraction of copper mineral from the ore milled apparently approximates the average percentage recovery of some of our most modern ore-dressing plants, which latter, at their respective normal rating, generally effect a recovery ranging from 69% to 77% of the contained copper in the ore milled, it being understood that the ore treated is, in the instance mentioned, of the same general character and grade.

From the foregoing it will doubtless be of interest to note that two methods are employed at Hayden, and the other plants under the same management, to make it appear that its milling practice is equally as efficient as the best. A brief outline thereof follows:

The first method employed considers the treatment of an ore averaging, say, 1.6147% copper per ton, the percentage recovery effected therefrom approximating .6835% of the contained copper, and the concentrator being operated at its normal capacity of 1000 tons per diem, Of course, it is comparatively easy to calculate the quantity of metallic copper recovered. However, the figures given are merely representative of "near-official" statements. The facts in the case are: First, maximum tonnage of ore is handled through the concentrator; secondly, the copper recovered is computed; thirdly, the percentage recovery takes care of itself; finally, by means of an elementary formula, a report is made which outlines, briefly, normal conditions of operation as aforementioned, care being exercised to make the copper produced bear a reasonable ratio of percentage recovery to a fixed tonnage of ore—and by all means not the quantity actually milled. It is simply a juggling of figures in which only the actual copper produced is considered—tonnage, percentage recovery, and other factors, being worked out as desired.

The second method contemplates the treatment of a higher grade ore than the general average mine-run, in which instance the tonnage passed through the mill is considerably less than the normall mill capacity. The conditions are, however, similar to those above mentioned.

At the present time the general average grade of ore treated in the concentrator averages from 2.00% to 2.86%, and higher, the percentage extraction ranging from 52% to 60%—dependent upon the tonnage handled, which fluctuates from 1200 to 1600 tons per diem. Maximum efficiency is sacrified to tonnage.

No better illustration of the inefficient operation of the concentrator is required than to call attention to the concentrate re-treating plant referred to in an earlier paragraph. Its installation plainly evidences the imperfect separation of the copper minerals from the ore treated in the plant as now arranged. Further, the sections of the mill where important changes of equipment readily could be made, are not given the attention necessary to improve the practice. To the contrary, the practice in lieu of being simplified, is constantly undergoing changes which serve to complicate the situation.

It seems strange that the management of the Ray Consolidated Copper Company persists in the application of the same general milling practice that is in vogue in its Utah, and New Mexico, properties; especially, in view of the fact that the physical character of the ores in the three districts where extensive operations are now being carried on, are widely different. To this may be added the statement that the method of treatment outlined has not, in any instance, proved successful, although it has been tried out on ores representing practically the entire field of so-called "porphyry" copper ores, or, "disseminated" low-grade copper deposits.

It will be of interest to readers to learn that there is in successful operation, in practically the same district as the Ray Con. properties, a modern concentrating plant treating the same character and grade ore as the Ray Con. Company, and effecting an average recovery of 76.85% of the contained copper of the ore treated. A description of the concentrator in question will appear in an early issue of Mines & Methods, and a comparison of the relative efficiency of the two plants can then be made. Aside from the general treatment plan of the plant to be described as above mentioned, is the fact that several important changes have been made within the past few months which have tended to considerably increase the ef-

ficiency of plant referred to, in both a mechanical and a metallurgical manner.

HAYDEN SMELTERY.

In view of the close relation of the Hayden smeltery to the Ray Consolidated Copper Company's concentrator at Hayden a brief description of the former is given.

The Hayden smeltery lies about one-fourth mile southeast of the Ray Con. concentrator. Originally it was to have been constructed and operated by the latter company, but, through negotiations with the American Smelting & Refining Company, whereby the Ray Con. was assisted in the further financing of its other properties, an exchange was effected.

Primarily the smeltery was built to handle only the concentrate produced by the Ray Con. company, but in view of the probable construction of a branch railroad from Hayden to the Miami district the smeltery will doubtless be greatly enlarged.

Concentrate from the concentrator is transported to the smeltery ore-bins in standard-guage steel 50-ton cars. From the ore-bins the concentrate is delivered over a belt-conveyor to eight 24-ft. McDougal roasters. The calcined material from the roasters is drawn into electric-driven hopper-bottom steel cars and emptied into hoppers feeding two 20x112 reverberatory furnaces, the furnaces being oil-fired. The copper matte from the reverberatory furnaces is delivered to two Pierce-Smith basic converters, the product from which is, in turn, cast into 375-lb. ingots and shipped to the refinery.

Six 400 h.p. Babcock and Wilcox water-tube boilers, operating at a guage-pressure of 175-lbs. are fired by the waste heat from the reverberatory furnaces, the steam generated by these boilers being piped to the Ray Con. power plant.

The smeltery derives its electric power from the Ray Con., and the Nordberg blowing engine, the oil pumps tending the furnaces, and other similar equipment is located in the Ray Con. power house, the arrangement having been made for an exchange of steam from the smeltery waste-heat boilers for all other power requirements, such as electric-power, and so forth, from the central power plant.

The equipment of the Hayden smeltery will be increased as occasion demands, and it is the intention of the A. S. & R. Co. to enter the field for both custom lead and copper ores at an early date. Consequently, there will be added to the present equipment several large water-jacketed cupola lead, and copper, furnaces, besides later the construction of its own power plant.

The Guggenheim Smelter at Hayden.

THE DIVINING ROD

The United States Geological Survey states in Water-Supply Paper 255, entitled "Underground Waters for Farm Use," just reissued, that no appliance, either mechanical or electric, has yet been devised that will detect water in places where plain common sense and close observation will not show its presence just as well. Numerous mechanical devices have been proposed for detecting the presence of underground water ranging in complexity from the simple forked branch of witch hazel, peach, or other tree to more or less elaborate mechanical or electric contrivances. Many of the operators of these devices, especially those who use the home-cut forked branch, are entirely honest in the belief that the working of the rod is influenced by agencies—usually regarded as electric currents following underground streams of water—that are entirely independent of their own bodies, and many people have implicit faith in their own and others' ability to locate underground water in this way. In experiments with a rod made from a forked branch it seemed to turn downward at certain points independent of the operator's will, but more complete tests showed that this downturning resulted from slight and, until watched for, unconscious muscular action, the effects of which were communicated through the arms and wrists to the rod. No movement of the rod from causes outside of the body could be detected, and it soon became obvious that the view held by other men of science is correct—that the operation of the "divining rod" is generally due to unconscious movements of the body or of the muscles of the hand. The experiments made show that these movements occur most frequently at places where the operator's experience has led him to believe that water may be found.

The uselessness of the divining rod is indicated by the facts that it may be worked at will by the operator, that he fails to detect strong water currents in tunnels and other channels that afford no surface indications of water, and that his locations in limestone regions where water flows in well-defined channels are no more successful than those dependent on mere guess. In fact, its operators are successful only in regions in which ground water occurs in a definite sheet of porous material or in more or less clayey deposits, such as pebbly clay or till. In such regions few failures can occur, for wells can get water almost anywhere.

The only advantage of employing a "water witch," as the operator of the divining rod is sometimes called, is that crudely skilled services are thus occasionally obtained, for the men so employed, if endowed with any natural aptitude, become through their experience in locating wells shrewd, if sometimes unconscious observers of the occurrence and movements of ground water.

To prevent rubber packing from blowing out, cut pieces of ordinary wire window screen the size of the packing and place on each side of it. The wire beds itself into the soft packing and holds it in position.

From Copper To "Gold Mines"

This space is reserved for the picture of A. F. Holden, the other eminent engineer who lent his name and gave his endorsement to the electrifying report on Alaska properties submitted herewith and which will be reproduced from month to month.

NOTED ENGINEERS JOIN BROKERAGE HOUSE IN A REMARKABLY PECULIAR PRESENTATION OF AN ALASKA GOLD MIRAGE.

We have considered the PROBABLE capital requirements for a capacity of 6,000 tons per day, which contemplates a hydro-electric power plant; mine development and equipment including all the necessary living quarters, both at the Perseverance mine proper and at the mill, and driving the long adit tunnel. We BELIEVE that $4,500,000 will do this owrk.

Our belief is that the substantially INDICATED ore body is about 4,500 feet long by seventy feet wide. The value of the 600,000 tons of ore THAT HAVE BEEN MINED FROM THIS BODY IN THREE DIFFERENT LARGE STOPES INDICATES that a recovery of at least $1.50 per ton can be made. We BELIEVE that there will be 75 cents per ton profit in this grade of ore. The Sheep Creek Tunnel which will be driven on the vein as the main haulage level, will develop this ore body at an average depth of about 2,200 feet on the dip of the vein or about 700 feet deeper than present developments.

The character of this vein is similar in A VERY GENERAL WAY to other large deposits of gold ore in the same vicinity in which the values at a vertical depth of 1,600 feet, or 2,000 feet on the dip of the vein from its apex, are practically the same today as they were on the surface, and have been throughout the development of THE DEPOSITS IN QUESTION. We visited these mines and saw THEIR deep levels, and if there is any inference to be drawn from the continuity of THESE ore bodies, WHICH ARE NOT, HOWEVER ON THE SAME VEIN AS THE PERSEVERANCE, one MIGHT BE TEMPTED to say that there is a PROBABILITY of ore 2500 feet deeper than the so-called Sheep Creek Tunnel which we contemplate driving. BUT, while the PROBABILITY is there of the vein and values extending to great depth, THERE IS NOTHING TODAY TO WARRANT ANYBODY IN STATING THAT IT IS A FACT THAT SUCH WILL BE THE CASE.

There are substantially 50,000,000 tons in the ore body we consider definitely INDICATED. There is a PROBABILITY of another 2,000 feet to the east of the 4 500-foot ore zone previously mentioned which, from surface indications, would seem FAIRLY CERTAIN to contain ore. Beyond this is some 1,800 feet of the vein concerning which we have NO FINAL OPINION one way or the other, AS WE VISITED NO WORKINGS OR OUTCROPS from which we could secure sufficient data to form accurate deductions. While we cannot at this time state that there IS ore here, there were several SMALL MINES worked almost at the extreme east end of the vein on this property, which INDICATES that this 1,800 feet will undoubtedly produce considerable ore and PERHAPS LARGE QUANTITIES. If we do not consider this in the PROBABILITIES, it is certainly well within the POSSIBILITIES.

This letter is based solely on a consideration of $1.50 recoverable value as ore. If one should figure on lower values assuming 75 cents as the total cost of mining and milling, the tonnage now indicated is INDEFINITE, but certainly enormous. We BELIEVE that sound mining business will INDICATE that for the installation now proposed and for an operating period of, say, two years, IT WILL BE WISE TO CONFINE OUR WORK TO THE HIGHER GRADE ORE. There can be, in our opinion, little doubt that at some time in the comparatively near future A VERY MUCH LARGER PLANT than the one now proposed will be installed for the purpose of working a larger tonnage of the normal grade ore we now EXPECT will be developed, or of utilizing the apparently vast quantity of lower grade material.

The INDICATED earnings from the installation now contemplated are approximately $1,500 000 per annum. Considering the TREMENDOUS POSSIBILITIES, and we use the word "tremendous" advisedly, we BELIEVE this mine to be a LEGITIMATE purchase at $15,000,000 and A BARGAIN at $12,000,000, provided that, in both cases, a development,equipment and working fund of $4,500,000 is made available. You must understand and appreciate that we do not consider the 6,000-ton per day development and installation as the ultimate possibility of the mine or anywhere near it. The POSSIBLE tonnages of ore INDICATED in this property APPEAR to be greater than any vein deposit WE know about.

We EXPECT the first unit of the new mill to be in operation on or before January 1st, 1915. We really BELIEVE that, barring accidents the time MAY be made July 1st, 1914.

(Signed, July, 1912.) D. C. JACKLING.
A. F. HOLDEN.

Already the management of this herculean undertaking is preparing to increase the stock and issue bonds under the bold assumption that the 50,000,000 tons of ore now "believed" to exist will be increased to 200,000,000 tons within a short time. This showing, an article in the Salt Lake Telegram of the 2th, says, will require making the proposed 6000-ton mill a 20,000-ton affair. Thus, before it is known whether the ore can be treated at any profit—really before it is known whether the ore will average even 25 cents a ton in recoverable value, the company's proposed new financing scheme is being exploited. First they tell you they "believe" $4,500,000 will be ample for all purposes of development and equipment. Then, almost before the ink is dry on that published statement, they begin paving the way for bleeding the public proper. The next stock will be put out at $20 or $25 a share, they promise.

COPPER ORE TREATMENT BY FLOTATION PROCESS

By J. W. ASHCROFT*.

The Kyloe Mine is situated near the township of Adaminaby, and is thirty-two miles from Cooma, New South Wales, the nearest railway station.

The orebody occurs as a lode quartz felsite, which, at the lower levels, passes into aplitic granite. In the upper levels of the mine there is an occurrence of slate which also shows on the surface, but is not present in the deeper portions of the mine.

At the time when the present management took charge of the mine, the oxidized ore was practically exhausted. The ore, as now mined, consists of quartz with chalcopyrite and small amounts of bornite and iron pyrites. The composition of a typical sample of clean, rich, hand-picked ore is as follows:

	%
Cu.	21.2
Fe.	24.3
SiO_2	28 9
S.	25.1
Bi.	trace
Au and Ag	trace
	99.5

In places the orebody is found in the form of small veins in a crushed felspathic filling. A clay seam, or gouge varying from one inch to over a foot wide, occurs in the ore-channel throughout the workings. This clay, and that derived from the kaolinizing of the felspathic portion of the granite filling, was the cause of a good deal of trouble in the flotation treatment. A remedy was subsequently found in the addition of a large proportion of clean quartzose ore.

THE ORIGINAL PROCESS OF TREATMENT.

In the mill, as originally erected, the ore, after hand-sorting at the shaft bins (where waste was eliminated, and some clean copper ore picked out for shipment), was passed through a rock-breaker and broken to 1½ in. gauge and delivered on to a picking-belt, where as much as possible of the clean, rich ore was bagged for shipment.

The remainder then passed into the mill ore-bins assaying from 5 per cent to 5¼ per cent of copper. A typical analysis of the average ore-treated is as follows:

	%
Iron	6.5
Copper	4.7
Sulphur	5.2
Lime	3.4
Insoluble	79 4
	99.2

From the mill-bin the ore was fed mechanically into an elevator, which discharged into a shaking screen. From this the oversize was fed, with water, into a set of Cornish rolls, and the undersize went to a May jig.

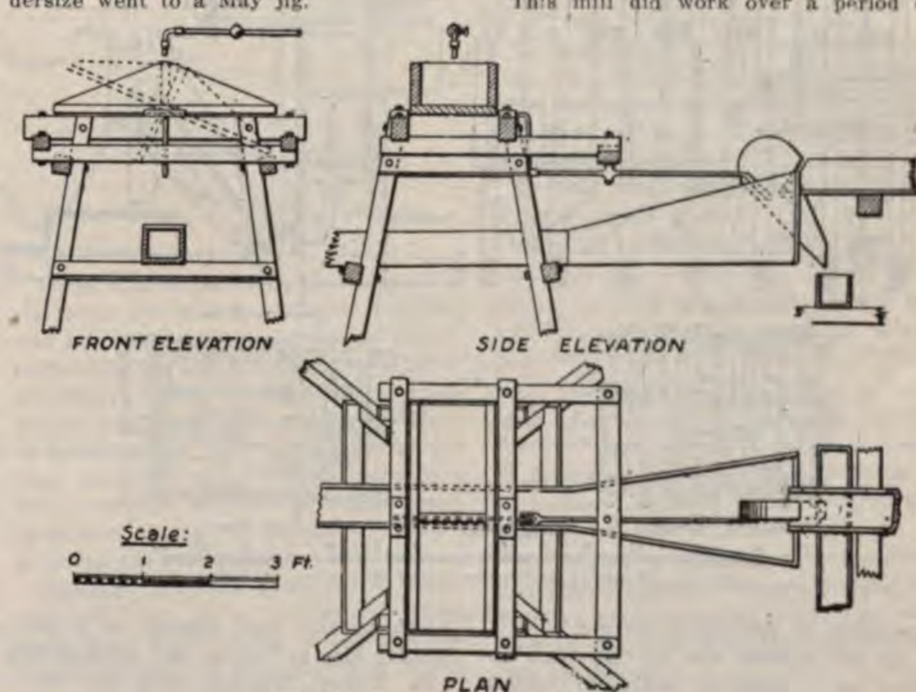


Fig. 1.—Flotation Tailings Sampler.

From the rolls the crushed ore fell into an elevator, and was once again fed into the shaking screen, together with the ore from the bins.

This arrangement is shown in the following flow-sheets, Nos. 1 and 2:

An automatic sampler was placed in the launder leading to the jig, so that all material passing into the mill for treatment was correctly sampled.

While no originality is claimed for this sampler, a drawing of it is shown on Fig. 1, as it is doing excellent work and may be of use in other plants.

The head product from the jig was dried, bagged and sold to a smelter, the tail ran to waste, and the middle products were reground wet in a ball mill, and, after classification, passed over Wilfley and Card tables, the overflow from the classifier being thickened in a pulp-thickener, from the overflow, which consisted of practically clear water, was run to waste.

An abundant supply of good soft water was obtained from the Eucumbene river, 1½ miles away. Subsequent experiments at other mines have shown that the character of the water has a noticeable effect on treatment by flotation.

This mill did work over a period of 18 months, recovering 74 per cent of the copper contained in the mill feed in the form of a concentrate carrying 19 per cent to 20 per cent of copper.

The mill concentrates were formerly smelted on the ground and the product shipped as a 50 per cent copper matte, but owing to the high cost of firewood and fluxes, and an all-round increase in the rates paid for labor, it became more profitable to sell the concentrates to a smelter.

The cost of transport is extremely high, viz., £2 15s. 0d. per ton of concentrates from mine to the smelting works, and it is, therefore, essential to

*Paper in Bulletin No. 97, I. M. M.

produce concentrates of as high a grade as possible. By lowering the grade of the concentrates, a higher extraction could have been obtained, but the extra cost of transport, and the lesser price paid by the smelter on the lower grade product, made it more profitable to ship one containing at least 20 per cent of copper.

EXPERIMENTAL FLOTATION TREATMENT.

With a view of obtaining a better recovery and a higher grade concentrate, experiments were made with the Potter and the Minerals Separation process of flotation, and, with the preliminary tests proving satisfactory, it was decided to erect a flotation plant; that of the Minerals Seperation was chosen, as it possessed advantages over the others as far as the treatment of Kyloe ore is concerned, in that it is more simple in

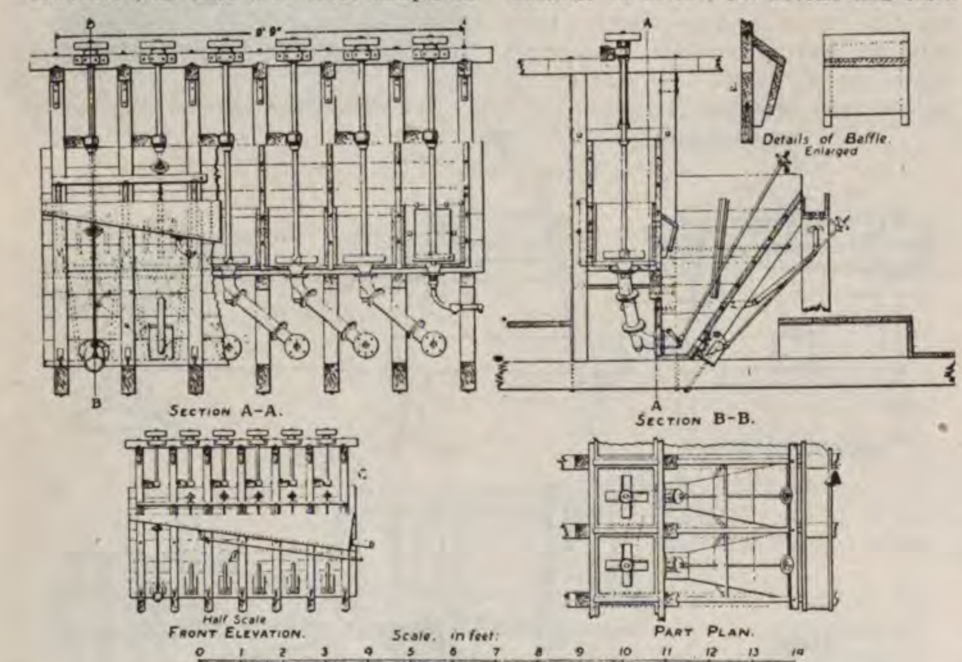


Fig. 2.—General Arrangement of Flotation Machine.

operation on this particular ore.

As the process was at that time untried on a working scale for copper ores, the old plant was left intact and a small annex added to the mill building to contain the flotation plant, and the lay-out so arranged that the whole of the work could be turned over alternatively to the original plant at any time; this proved to be a wise precaution, as radical alterations were necessary to the flotation process as first introduced before success was achieved.

The flow-sheets accompanying this paper show the evolution of the present method from the original mill as already described.

The flow-sheet, as far as the point of departure in treatment after the jig, has already been given and are common to all. Sheets Nos 3 and 4 show:

3. The first lay-out of the flotation plant;

4. The present arrangement of flotation plant as now in successful operation.

PROCESS AS FIRST INTRODUCED.

This plant is divided into two sections, i.e., a grinding section and a flotation section.

The grinding was effected in two 8-ft. Forwood-Down pans; as originally erected these were made with a classifying discharge and were driven at 30 rev. per minute.

The flotation machines are of the latest type used at Broken Hill on the zinc-lead seconds, with six stirring boxes, each 16 in. square, as shown in Fig. 2.

The departure from the former method of concentration took place at the jig. The first hutch product was clean concentrate as before, the second and third hutch product was dressed on a No. 5 Wilfley also as before; the tailings from this Wilfley, together with the No. 4 hutch product and the jig tails, were sent to the grinding pans, and the overflow from classifier at the head of jig, together with the overflow from end of jig, passed through a pulp-thickener of the baffle-board type, the spigot from which discharged into the launder running to the flotation machine together with the discharge from the grinding pan. No. 3 flow-sheet on shows the first lay-out of the flotation plant.

The pulp-thickener, which is an adaptation of a well-known type, calls for special attention, being of cheap and simple construction, and working admirably. The details of this apparatus are shown on Fig 3.

The flotation machine consists of a series of six square boxes fitted with revolving impellers, and each box connected to an outside chamber in which the separation of the mineral from the gangue takes place. From the bottom of the No. 1 flotation chamber the pulp is drawn by the action of the second impeller into No. 2 stirring box and from No. 2 flotation chamber to the No. 3 box, and so on; the pulp from which the mineral has been separated being finally discharged from the bottom of the No. 6 flotation chamber.

The flow from the flotation chambers through the diagonal pipes into the stirring boxes is regulated by a valve on the top of each pipe, and the tailings discharged by a similar valve.

In this flotation process, as used by Kyloe, no acid is required, and the whole operation is conducted at ordinary temperature. The oil used in crude eucalyptus oil containing a large percentage of philandrene. This oil is manufactured in the district, and costs 8.5d. per lb., delivered at the mine. A great deal of information concerning the manufacture and properties of the various eucalyptus oils is found in a publication entitled "Eucalyptus and their Essential Oils," written by Messrs. Baker & Smith, and published by the authority of the State Government of New South Wales.

DEFECTS IN THE PROCESS.

A number of defects soon revealed themselves in both sections of the plant. In the flotation machine the original slicing valves used were not sufficiently sensitive to regulate the flow properly, the correct adjustment of which through the different boxes has an important bearing on the successful working of the process, and the slicing valves were therefore replaced by flap valves, operated by a rod with threaded end and hand wheel, which arrangement proved entirely satisfactory, and permitted very delicate adjustment.

As soon as work was started it was found that owing to the flotation chambers being all of the same width, while the amount of mineral to be floated became less in each one towards the tail end of the machine, the froth became very thin and poor after the first two boxes; to remedy this and give the froth a greater density and thickness, the flotation chambers were contracted on top by means of "crowding boards" which reduced their surface to widths varying from 11½ in. on No. 1 to 4½ in on No. 5. No. 6 chamber was shortened by putting in a watertight bulkhead in addition to the crowding boards as in the other chambers; this narrowed the surface to 4 in. and shortened the distance through which the poor froth had to travel by one half, and gave less chance for the mineral to drop away

from the froth into the tail before it was delivered into the discharge launder.

The machine now appeared to work fairly well, but the following samples, taken from the discharge lip of each of the flotation chambers, showed that the product from Nos. 4, 5 and 6 chambers were not sufficiently rich to be profitably shipped, so the concentrate launder was divided and arranged so that the products from Nos. 1, 2 and 3 chambers went to the concentrates bin, while those from Nos. 4, 5 and 6 were returned to No. 1 box in the machine and re-treated.

This, although an improvement, was not yet satisfactory, so sizing tests of the various products were made to discover, if possible, in what direction to look for further improvement. The results were as follows:

Mesh.	Feed.		Concentrates.		Tailings	
	%Wt.	%Cu.	%Wt.	%Cu.	%Wt.	%Cu.
+ 20	1.52	2.20	0.18	17.50	1.85	2.0
+ 40	13.17	1.20	0.30	17.00	17.53	1.2
+ 60	15.10	0.80	0.31	18.50	20.77	0 7
+ 80	3.55	1.15	0.52	24.70	6 10	0.6
+100	22.50	1.40	7.42	53.60	21.40	0.6
+130	3.62	3.80	1.55	21.20	4.20	0.5
—130	40.40	5.45	89.60	23.75	28.00	1.2

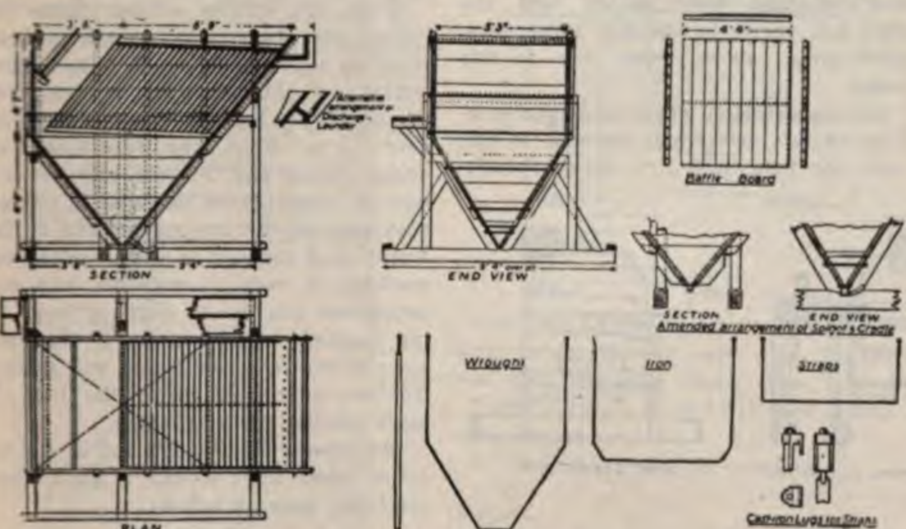


Fig. 3.—Improved Pulp Thickner.

The samples referred to were as follows:

	Copper	Silica
	%	%
No. 1 Overflow	27.2	21.2
" 2 "	24.1	41.5
" 3 "	22.3	59.6
" 4 "	15.6	61.0
" 5 "	14.3	60.7
" 6 "	9.4	68.7

After a short run it was found necessary to insert iron liners in the stirring boxes, as the wooden ones wore away very rapidly. The opening into the boxes through which the pulp was drawn by the action of the impellers was also modified and made bell-mouthed, which improved the working considerably. Inspection doors were also provided, so that the wear could be ascertained without dismantling the boxes.

As soon as the machine was again working normally, samples of the feed and tail were taken regularly, and the result of a week's run was as follows:

	Feed.	Cons.	Tails.	Recov.
	%Cu.	%Cu.	%Cu.	%
1st day	5.1	20.1	2.0	67.5
2nd day	4.4	24.2	2.3	52 7
3rd day	4.0	19.1	1.2	73.8
4th day	4.7	19 0	2.2	60.1
5th day	4.0	23.6	1.5	66.7
6th day	4.1	23.5	2.2	49 8

These figures indicated that the material being fed into the flotation machine was not sufficiently uniform, and that it containedl too large a quantity of comparatively coarse particles which could not be held up in the froth, and which in falling would carry down some of the finer particles that would otherwise have remained suspended. Improvement, therefore, lay in the direction of finer grinding and closer sizing.

Attention was now given to the crushing unit, and, as a preliminary, sizing tests were made of the infeed and discharge of the two grinding pans, which gave the following results:

	No. 1 Pan.				No. 2 Pan.			
Mesh.	Feed.		Discharge.		Feed.		Discharge.	
	%W.	%C.	%W.	%C.	%W.	%C.	%W.	%C.
+ 16	16.4	2.3	—	—	10.0	1.4	—	—
+ 20	33.9	1.6	10.0	1.71	9.7	1.0	0.3	—
+ 40	13.0	1.3	17.1	1.2	10.5	1.2	11.0	1.4
+ 60	18.3	1.2	31.9	1.4	18.2	1.5	30.9	2.1
+130	6.9	2.1	16.9	3.2	17.0	3.0	23.4	4.1
+130	11.5	3.7	24.1	5.0	24.8	6.7	34.4	6.2

The No. 1 pan was taking the product of Nos 2 and 3 hutch from the jig after being dressed on a Wilfley table The discharge was 21 in. above the bottom of the pan.

The No. 2 pan was taking the overflow from the classifier at the head of the jig and a portion of the jig tail, the discharge was 22 in. above the bottom of the pan. The pans as arranged with the classifying feed would not take the whole of the jig tail.

As the foregoing sizing tests showed that an unduly large percentage of material, larger than 40-mesh, was contained in the ground pulp, the discharge of the pans was slightly raised and the product again sized, with the result that while the quantity of slime made was largely increased, the amount of product, larger than 40-mesh, was very little reduced.

The working of the machine was still unsatisfactory, the recoveries in the whole mill being only very little better than with the old system; but as all laboratory tests showed that a much better extraction was possible when the conditions were favorable, and as the trouble appeared to be chiefly mechanical, it was decided to rearrange the whole of the flotation plant so as to remedy the most apparent defects, which were:

1. The excessive amount of oversize in the feed to the stirring boxes.
2. The excessive dilution of the pulp.
3. The irregularity of the overflow from the flotation chambers due to the irregularity of the feed, and of the speed of the impellers.
4. The want of proper means to control the supply of oil.

REARRANGEMENT OF PLANT.

In order to remedy the defects mentioned the mill was turned over to the old system while the following alterations were made in the flotation plant:,

1. The grinding pans were altered from the classifying discharge, to the positive feed type, and were arranged to discharge on to revolving screens so as to keep the feed to the flotation machine more even in size.

2. The pulp thickener was moved and placed between the screens and the flotation machine so as to keep an even feed to the stirring boxes and to regulate its density.

3. The flotation machine was connected to a separate engine with a sensitive governor so as to keep the speed of the stirrers constant.

4. An apparatus was made for adding the oil to the pulp in such a manner as to ensure an even flow.

The revolving screens are of a type used in Broken Hill and are shown in Fig. 4; they do excellent work and are economical to run.

The screening cloth used in Greening's L. W. C. 600-mesh with aperture 0 0268 in.; size A.K.D. 900-mesh with aperture 00217 in. was also used at first, but the L.W.C. was found to last longer and to give equally good results and so

was finally adopted. The screens last about ten weeks for each covering.

The method of adding the oil to the pulp, which was finally adopted, consists in placing two drums, one above the other; in working, the top drum is filled with oil and the flow from this to the lower one is regulated by a floating ball valve, thus ensuring a constant head in the lower drum. From the lower drum the oil drops at a constant rate into the launder which carries the pulp from the screens to the flotation machine, at the rate of about one drop per second, amounting to 0.65 lb. of oil per ton of dry ore treated.

In the rearrangement of the plant no concentrating tables were used at all, but the whole of the products from the jig, excepting that from the No. 1 hutch (which was bagged for shipment) were sent direct to the flotation plant in order to give a larger percentage of mineral there, and so form a thicker froth in the flotation chambers.

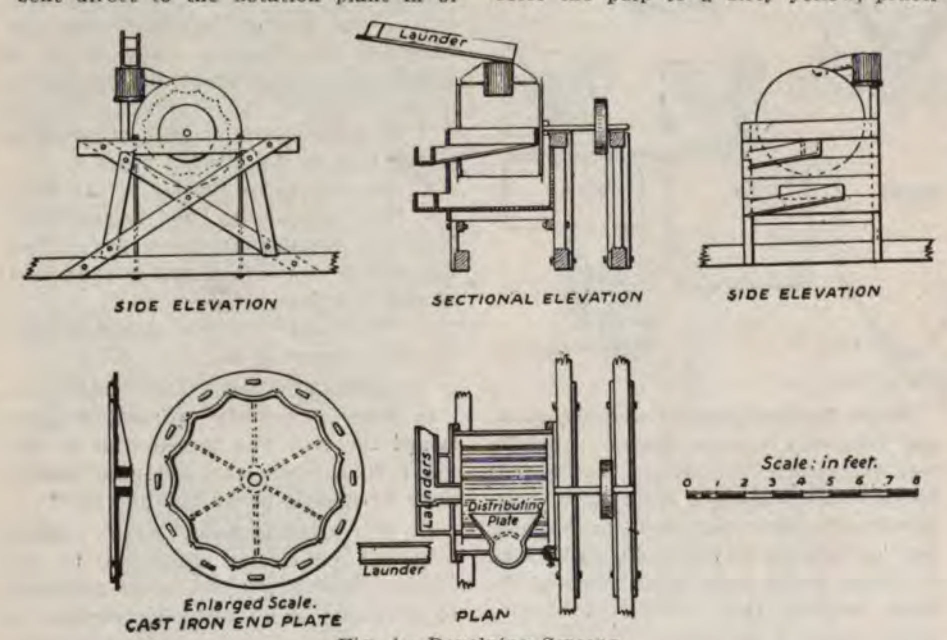


Fig. 4.—Revolving Screens.

Flow-sheet No. 4, here given, shows the rearrangement, and it will be seen from it that the only actual additions to the plant as originally designed are the screens and elevator, but that there is a considerable difference in the general lay out.

Having remedied the defects in the grinding plant the flotation machine began to do much better work, the result of a six days' run being as follows:

	%Cu.	%Cu.	%Cu.	%
1st day	3.9	23.8	1.1	75.2
2nd day	4.0	21.4	0.9	80.4
3rd day	4.7	25.4	1.0	82.0
4th day	4 8	25.8	1.4	74.8
5th day	5.3	26.1	1.4	78.0
6th day	4.1	25.6	1.5	67.3

The extraction percentage above is worked out on the following formula, viz:

$$\frac{+\ 100\ C}{A} = \%\ \text{extraction}$$

Where A = percentage of value in feed
B = " " " tail
C = " " " concentrate

which is convenient for approximate estimations when it is impracticable to weigh the products.

It was soon found that a certain type of feed gave bad results, i.e., where there was a large percentage of oxidized and kaolinized lode matter, and the high tail values in the last three days' work given above were due to this cause.

On one occasion when there was sufficient of this deleterious material to discolor the pulp to a dirty yellow, practically no flotation took place, the pulp leaving the boxes at approximately the same value as it was fed in. There was no true froth, only large, shiny bubbles, and a little coagulated sulphide which overflowed the flotation chambers; samples taken from each chamber at this time gave the following results:

Feed % Cu....................	3.5
Chamber No. 1 %Cu.	9.3
Chamber No. 2 %Cu.	8.2
Chamber No. 3 %Cu.	6.3
Chamber No. 4 %Cu.	7.3
Chamber No. 5 %Cu.	6.5
Chamber No. 7 %Cu.	8.8
Tails	3.0

The film forming these large bubbles was very tenacious, and no improvement took place while the feed was discolored in this way.

Tests made indicated that the deleterious effect was due to the physical rather than the chemical properties of the material and to the peculiar nature and excessive quantity of the slime produced by it; in order to determine definitely what effect the large quantity of slime had upon the working of the process, daily sizing tests were made of the infeed to the flotation machine extending over a considerable period, and these showed that when this contained more than 40 per cent which would pass through 130-mesh, the quality of the work began to fall off, while the best results were obtained with from 20 per cent to 30 per cent of this size in the feed.

Since the trouble arising from the "dirty" ore, the mill feed has been regulated so as to contain only a small percentage of this in the total feed, and the result has been uniformly good, only once in a while the separation becomes poorer and this can now be very quickly corrected by the man in charge, who can tell by the appearance of the froth; once running in proper order, the machine is easy to regulate, and will sometimes run for 48 hours without being touched, but at others, if the character of the feed changes, it will require frequent adjustment until the feed is again regular in composition.

The results of a week's run of the flotation plant when it was in good working order were as follows:

	Feed. %Cu.	Cons. %Cu.	Tails. %Cu.	Recov. %
1st day	3.8	25.1	0.95	77.9
2nd day	3.0	23.3	0.85	74.3
3rd day	3.0	24 2	0.65	81.0
4th day	3.15	23.7	0.55	84.5
5th day	4.1	25.6	1.05	77 5
6th day	4.4	24.6	0.90	82.5

These figures show a recovery better than is obtainable by any other known concentrating process on this class of ore, and when it is remembered that, in the case of the Kyloe ore, the mineral contained is nearly pure chalcopyrite, the tailing values are very low.

DRYING THE CONCENTRATES.

The concentrates made are in a very fine state of sub-division and very frothy; filtration was tried as a means of getting rid of the water, but proved a failure without the aid of presses or vacuum plant. It was found, however, that by running the material into a tank and spraying the surface, the froth was broken up; the introduction of a baffle board at the overflow end of the tank caused the mineral to settle and allowed an overflow of clear water. There are two of these tanks in use, and the concentrates are settled in each one alternately, the water is run off as closely as possible, and the wet concentrates then shoveled out on to a drying floor, heated from underneath, and from there,

when sufficiently dry, into bins ready for bagging.

The plant has now been in successful operation for six months, the mill recoveries from July 29th, 1911, to January 27, 1912, inclusive, being as follows:

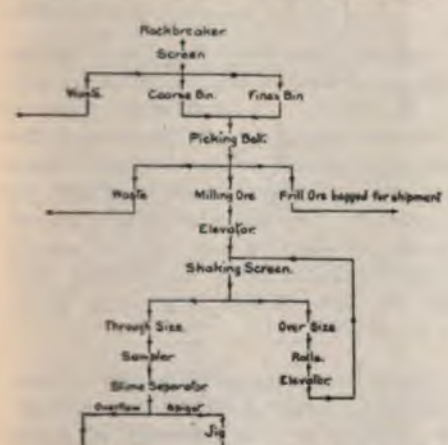
Tons ore treated	7855.00
Tons of copper contained ..	411.97
Assay value of ore %Cu. ...	5.24
Tons concentrates made ...	1562 00
Tons of copper contained ...	335.79
Assay value %Cu.	22.65
Extraction %Cu.	83.36

The recoveries are those for the whole of the concentration plant, and are worked out from the weights and values of concentrates made and shipped as against the daily assay of the mill feed. The actual recovery in the flotation plant apart from the jig is approximately 80 per cent on a 3.5 per cent feed and the assay value of the flotation concentrate is over 25 per cent copper. It is as well to state here, that it has been proved by experiment that the extraction could be increased up to 92 per cent or over, by lowering the grade of the concentrates, but, as already explained, owing to the high transport charges, there is more profit in making the higher grade product even though doing so involves making a smaller recovery.

Nº 1 Flow Sheet

From Rockbreaker to Jig

which is the same for all arrangements of the Mill



In order to demonstrate this clearly, the following figures are given for 100 tons of ore:

The costs of transportation per ton were as follows:

Cartage to railway station	£1	12	6
Trainage to smelting works..	0	13	10
Agency and sundry charges ..	0	1	6
Bags and bagging concentrates	0	7	2
Total per ton of concentrate.	£2	15	0

The feed in both cases is taken at 5.24 per cent copper.

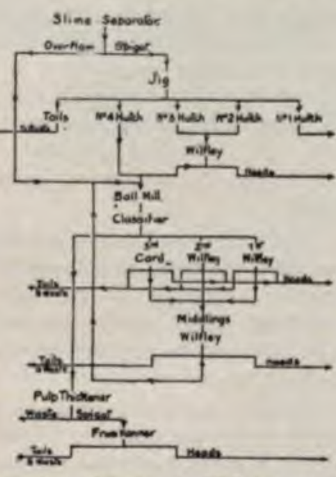
1st case—

Making an 86 per cent recovery with a 22.6 per cent concentrate as at present 86 per cent of 5.24=4 5064 tons copper, and 4.5064 tons copper=19.94 tons of 22.6 per cent concentrates.

Copper is taken at £60 per ton.

Nº 2 Flow Sheet.

Shewing wet concentration lay-out as adopted in the original Mill.



Returning charge on 22.6 per cent material is 2s. 7d. per unit, with 1.3 per cent deducted from assay value.

Then 22.6—1.3 = 21.3×19.94 = 423.33 units copper.

423 33× (12s.—2s. 7d.)=9s. 5d. £199 6 4

Deduct—

19.94+3% moisture=20.54 at £2 15s. 56 9 8

Net return £142 16 8

Nº 3 Flow Sheet.

Shewing first lay-out of Flotation Plant

2nd case—

Making a 92% recovery with a 19% copper concentrate:

92% of 5.24=4.8208 tons of copper, and 4 8208 tons copper=25.37 tons of 19% concentrates. Returning charge for this grade is 2s. 9d. per unit.

Then

19—1.3=17.7×25.37=449 05 units copper, and 449.05×(12s.—2s. 9d.=9s. 3d.)= £207 13 8

Deduct—

2537+3% moisture=26.13 tons at £2 15s 71 17 2

£135 16 6

or a difference in favor of the lower recovery and higher grade concentrate of £7 0s. 2d., equal to 1s 5d. per ton of crude ore of 5.24% original value in copper. It is thus clear that under the conditions existing at Kyloe it is essential to keep the concentrates to as high a grade as possible, even at the cost of sacrifice in the recoveries.

COST OF RUNNING FLOTATION SECTION.

The actual cost for the twenty-four weeks from July 3rd to December 16th, 1911, were as follows:

Ore milled 8556 tons. Residues treated, 5732 tons.

	Per ton of Ore Milled s.	d.	Per ton of Residues Treated. s.	d.
Re-grinding, screen and flotation.....	1	3.6	1	11.2
Power	0	2.3	0	3.4
Drying and handling concentrates	0	3.8	0	5.7
Maintenance and renewals	0	6.6	0	9.8
Assaying, lighting, etc.	0	2.3	0	3.4
Water supply	0	3.4	0	5.1
Superintendence, proportion of management and office expenses	0	2.1	0	3.3
	3	0.1	4	5.9
Royalty	0	6	0	9
Total cost	3	6.1	5	2.9

The royalty paid is saved by the Kyloe company in the lesser returning charge from the smelters due to the higher grade of concentrate made.

Nº 4 Flow Sheet.

Shewing present arrangement of Flotation Plant as now in successful operation

During the first three months of this period a portion of the jig residues were run to waste, as owing to the want of power the pans could not take the whole of them; this has since been remedied and the cost per ton of residues treated

is now only about 10% over the cost per ton of total ore milled.

These costs include the re-lining of the stirring boxes with iron liners in place of the wooden ones originally put in, and also some alterations to the pans, which makes the item "Maintenance and renewals" appear high. The cost of oil, which is included under (1) is 5.2d. per ton of residues treated, or 3.5d. per ton of ore milled.

The total cost of milling for the period, including crushing, belt picking, jigging, re-grinding tails and flotation, together with all maintenance costs and proportion of management and office was 7s. 8.7d. per ton, and the cost of delivering the ore from the mine to the mill bins was 3.3d. per ton.

The mine being a small one, the tonnage available for treatment is also small, i. e., 60 tons per day, and costs are therefore higher than they would be on a large tonnage, but owing to there being no acid required, no heating of solutions, and to the more favorable conditions existing at Kyloe, the flotation costs are considerably lower than they are at Broken Hill, where the process is worked on the zinc-lead tailings.

The cost of plant will necessarily vary with local conditions, but owing to the very small space occupied and the simplicity of the apparatus employed, it will probably cost 25% less to install than a corresponding wet dressing mill with tables, slime plant, etc.

CONDITIONS FOR SUCCESSFUL WORKING.

So far, present experience indicates that any clean sulphide of the metals can be treated if the physical conditions are right; these are:

(1) That the particles must be clean and free from oxidation.

(2) That the gangue must not be of so clayey a nature as to form a fine slime which coats the surface of the sulphide particles and prevents their attaching themselves to the bubbles formed, or which in itself forms too large a proportion of "gangue slime" which comes up with the froth and destroys its holding power for the sulphide.

(3) The material to be treated requires to be ground as evenly as possible; the best size has to be determined on each individual ore.

(4) The feed and speed of the stirrers must be correctly proportioned and kept as even as possible.

(5) The thickness of pulp fed into the machine must be regulated and kept as even as possible.

(6) The minimum amount of mineral required to be present in the ore has not yet been determined; at Kyloe it amounts to approximately 10% of the weight of the ore, and this gives excellent results. Experiments are now being made to determine if possible the minimum amount allowable; any excess can, of course, generally be removed by jigging or some other form of concentration before flotation.

In some cases the addition of clean pyrites may be beneficial, but as the successful float depends largely upon the total quantity of minerals, rather than the percentage in the ore, it is in many cases possible, by keeping it back in the flotation chambers, to treat successfully very low-grade material. This must, however, be tested on each ore separately.

(7) The water used has a marked effect on the process, and necessitates modification according to its hardness and chemical constituents, but a bad water is not necessarily detrimental to the working of the process.

The machines as now used are a great improvement on the old type of pointed boxes, and will no doubt be further improved upon as experience suggests modifications.

The grinding of the ore to prepare it for flotation may be done in nearly any form of machine, provided that it does not make too much slime, although the process can work successfully with a considerable quantity. The best type of machine is one which screens off the material as soon as it is crushed and returns the oversize back again. The ideal to be aimed at is to keep the particles as nearly of a size as is practicable.

In the foregoing pages the poor success at the first starting of the plant has been dealt with rather fully, for the reason that the experience gained therefrom may be of use to others when starting on a new plant, and the following up of the various causes of trouble may assist in locating weaknesses in other installations.

In conclusion, the writer would state that the Kyloe company are very largely indebted to Messrs. Faul and Lavers, the engineer and chemist respectively of the Minerals Separation Company, for the ultimate success of their plant.

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The strike at Ely is over and some 2,000 men have returned to work. All this trouble, loss and expense might have been avoided if the managers had been wise and given their men a reasonable raise soon after copper went up, as was done at Butte and some of the other large camps. The "ounce of prevention" is nowhere more valuable than in the matter of labor disputes—Pacific Mining Journal.

Any machine, such as a concentrating table, which rejects certain material, is not fairly treated if that product is returned to it. If a middling product is rejected let another machine deal with it.

---o---

In the early days of Cripple Creek a man came down from the mines to Colorado Springs, and a friend meeting him on the street said: "Well, how are things up at the Creek?" "O!" said the miner, "the miners are looking for the gold where it ought to be, and the tenderfeet are finding it where it is."—Ex.

---o---

A dividend of 12½ cents a share has been declared by the Nevada-Douglas Copper Company, payable February 1, books closing January 10. This is the first dividend paid by any of the mines in the Yerington or Mason Valley districts, and amounts to $125,000.

---o---

A local brokerage firm in a recent "market letter" offers the following profound advice: "A profit once made is sure and should always be taken. The man with a well balanced mind is satisfied with a profit of 25, 50 or EVEN 100 per cent." Yes; and when it gets around to us, we want to say that we should think a man ought to be satisfied with 100, 75, 50, or EVEN 25 per cent profit.

---o---

Need for a general knowledge of mineralogy by working miners was evidenced recently by the discovery of a six-inch seam of scheelite at the Lady Rose mine, Victoria, Australia. The miners regarded the material as worthless, since there was no indication of gold in it, and large quantities of it which had been broken were discarded as worthless. A visiting engineer recognized the material as scheelite, of remarkably good quality, worth $400 per ton, much more than the gold-bearing quartz the miners were seeking.

---o---

Original, or "makeshift," methods of doing things can be seen and heard almost every day in the copper mines of upper Michigan. William was up in the stope at a freshly broken face, from which place he called to Tom, standing on the level, "Tom, ist there?"—"Ase, ase wat do 'ee want?"—"Go up top and fetch down bit stull"—"'Ow long of a stull do 'ee want?"—"A midlin' long un" —"Can't 'ee measure 'im?"—William measured in his own fashion and called back, "Tom, the bit stull I want 'e dha measures as long as a pick an' a pick 'andle, a gad an' a gad 'andle, taw bluddy wedges an' a big flat rock."

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CONTENTS:

where in this issue of Mines and ds will be found the descriptive of Miami mines and concentrat-lant. Aside from its general tech- and educational value to the en- and milling expert, it contains information that will interest the or. In the closing paragraph, for ce, the author, Mr. James O. Clif- calls attention to the method by the mill management seeks the every man about the plant in se- the best results. There is no con-ent; the right hand at the Miami afraid to let the left know what ions are, and as a result all hands in harmony with a determination ke the best possible record. At the the men have confidence in their yers and the employers repose the t confidence in their men. Such a ion augurs well for the sharehold- r it is evidence that those charged he mining and milling operations company are not afraid of honest ity, either at or away from the

"Stupendous Undertaking" of Utah Power & Light Co.

From the over-zealous tone and effusive uttearnces of the subsidized reporters of the local and Boston daily papers it is quite evident that some further financing stunts are shortly to be undertaken by the promoters of the so-called "stupendous undertaking"—the new Utah Power and Light Co. This latest publicity scheme pictures the multiplied "young millionaire" who occupies the company's chief office as contemplating the early electrification of all the great intermountain railroad lines in addition to supplying cheap power and light to all local users, while the farmers are to be similarly supplied with sufficient power to operate pumps enough to bring under cultivation all of the arid lands of the entire West.

This is most certainly a cheerful picture and we expect that announcement will soon be made that all that remains to carry this benevolent purpose into effect will be public subscription to an issue of $60,000,000 of convertible bonds; or, possibly for the present, the activity may have for its purpose only the completion of the financing of the $40,000,000 capital which forms the present basis of this dazzling enterprise. The purpose of this corporation, as announced to the public is, as a holding company, to take over certain independent operating companies located in Utah, Idaho and Colorado, and thus far it appears that every independently operated plant in the states named have been practically assembled and the ownership lodged in the holding company.

When we remember that all these plants were practically being operated at capacity of their resources and that their product was being marketed and consumed, it is difficult to conceive just how the combined plants will be enabled to enlarge their outputs sufficiently to provide the necessary energy to supply the demand of the enormously enlarged field of industry that comprehends the reclamation of all the arid lands of the West, the operation of the railroads, etc. Besides, the Utah Copper Company, on abandonment of its steam plant, becomes a preferred consumer of 15,000 to 20,000 horse-power which must be drawn from a supply already taxed to the limit.

It also is a fact that for some weeks prior to the announcement of the combination employes of the individual companies were actively engaged in soliciting extension of existing contracts for a period of years on the pretense that the growing demand was such that it would be difficult for regular patrons to secure a continuation of the regularly needed supply of power. And it is pertinent to observe in this connection that no reduction in price was offered, which price, in the case of small consumers, afforded a profit of anywhere from 100 to 150 per cent over the cost of production, the limit being just sufficiently below the cost of securing the energy from coal, together with the convenience that attends the handling of electric power, to make the latter preferable to the consumer.

With these facts before us we see little encouragement to the prospective farmer to undertake to secure a tract of these desert lands with a hope of securing cheap water for irrigation by means of electric power to be supplied by this benevolent combination. Stripped down to cold bedrock this corporation, with its magnanimous pretenses, in addition to the useless $1,500,000 steam plant of the Utah Copper Company, (soon to be abandoned), has succeeded in securing all of the independent, live, operating, cheap power-generating plants in three states at a cost probably not exceeding 30 per cent of its enormous share-capital, the balance being "velvet," and upon all of which the consumer must be so taxed as to afford an acceptable interest rate, for it must not be expected that rates already covered by contract will be reduced pending such contracts, or in the absence of an offer of competitive power at lower rates. And the demand for additional capital—under some pretense or another—will come just the same, whether any more available water power sites remain or not; and it will be interesting to note in what form the demand is made for additional public money when it comes.

GETTING READY TO "SOAK" THE PUBLIC

The Salt Lake Tribune of December 24 quotes Thompson, Towle & Co., on the Alaska Gold Mines fake as follows:

> We have been looking over the annual reports of the Alaska Treadwell Gold Mining company, in an endeavor to compare costs of mining there with the claims of a 75-cent mining and milling cost for the Alaska Gold Mines, and the conclusions would appear to be very much in favor of the Aelaska Gold Mines company as to ability to mine and treat a ton of its ore for 75 cents per ton.
>
> In the case of the Alaska Treadwell its total mining cost for 1911 was $1.0099, and its total mill cost 22.52 cents for its 240-stamp mill, and 18.20 cents for its 300-stamp mill.
>
> There is no question but what the Alaska Gold Mines company, with its new, big 6000-ton mill, containing the latest machinery, will be able to mill as cheaply as the Alaska Treadwell, but even allowing a 25-cent cost for milling, a total 75-cent cost would leave 50 cents for mining and delivery of the ore to the mill.
>
> In the $1 cost of the Alaska Treadwell for mining, are the following four items:

Machine drilling	.2685
Laborers	.2090
Power	.1846
Steam power	.1184
Total	7805

> Practically the greater part of this expense will be avoided in mining the ore bodies of the Alaska Gold Mines company, the ore being friable and breaking in immense masses, requiring little in the way of underground machine drills and power, and after the ore is once broken all other operations are practically automatic, therefore the labor costs are comparatively small. The power is developed from the company's own 5000-horsepower hydro-electric plant, so that the only cost on this item is interest on investment and upkeep of a few dollars per horsepower per annum.
>
> It is therefore safe to say that at least 60 cents of the total $1 cost of the Alaska Treadwell company will be saved to the Alaska Gold Mines company in its proposed system of treating its big masses of low-grade ores.
>
> As a matter of fact, in allowing an estimate of 75 cents for mining and milling this ore there was a leeway of at least 10 cents per ton given, and the management has anticipations of actually being able to mine and treat a ton of ore for 50 cents, which would leave a net profit of $1 per ton, allowing that the ores only averaged $1.50 per ton. But even in that respect we understand the values are underestimated about 15 cents per ton.

What drivel; what sorry rot! What straits a combination of loudly touted "world's greatest engineers" must find themselves in to permit such stuff to go out to the public. If there is any part of this presentation of the Alaska Gold Mines scheme that does not savor of fraud and dishonesty we should like to have it pointed out to us. There are some pretty bright men connected with the Thompson-Towle concern and it is inconceivable how they could bring themselves to father such statements. We had credited them with having at least some regard for their standing and reputations among men; and we dislike to believe, even now, that they have not been imposed upon.

With large mining interests and promotions of their own in different parts of this country; with a corps of capable engineers of their own constantly at work and in personal touch with every feature of the best mining, milling and smelting practice in mining regions everywhere, it would be a sad reflection on the intelligence of the personnel of the firm mentioned to intimate that they believed anything contained in the article quoted above. They know, for instance, that with all the advantages of cheap labor, perfect railroad facilities, ideal mining conditions and every other factor that goes to make for low cost records, none of the mines and mills operated in Utah, Nevada, Arizona, New Meico and Montana, by the men who are directing the destinies of the Alaska Gold Mines Company ever have been able to mine and treat a ton of ore for anything like 75 cents—a figure which Thompson, Towle & Co., declare is likely to be lowered to 50 cents a ton in a glacial, precipitous, wild region several miles back of Juneau, Alaska.

The statement quoted undertakes to make a point of the fact that the Alaska-Treadwell mining cost was nearly one cent over $1 per ton; that 78.05 cents of that amount was chargeable to machine drilling, power, labor and steam power; that most of these costs will be avoided by the Alaska Gold Mines, "the ore being friable and broken in immense masses, requiring little in the way of underground machine drills and power."

Of course the investing public might not stop to think about it, but Thompson, Towle & Co. knows that if the ground is soft and friable enough to mine and break down in "immense masses" without the aid of powder or drills, it will cost a great deal more to timber and make safe the underground workings than the costs referred to for power and drills could possibly reach. Thompson, Towle & Co., also know that while the Alaska-Treadwell puts its ore through several processes (concentration, amalgamation and leaching) and yet works the cost down to a trifle over 22 cents a ton as an average, the best record the Utah Copper Company's management (with its unapproachable (?) skill and limitless resources) has been able to make at its widely heralded "perfect" mills has been—using their own figures for it—42 cents a ton; and that cost record is produced in plants wherein nothing but the one process (that of simple concentration) is employed, and this upon an ore exceptionably friable and pulverulent.

It is simply impossible to believe that Thompson, Towle & Co. have any faith in the ability of the Utah Copper management—which is doing the engineering for Alaska Gold Mines—to cut even close to making a legitimate profit out of the stuff they are pleased to call ore at that company's properties.

If readers of Mines and Methods will take the trouble to again read the original report of Messrs. Jackling and Holden upon the Alaska Mines and then follow through the comment and criticism of this publication, they cannot fail to see that every effort now being made to bolster up the proposition has been called out by our exposures of its utter worthlessness and present exigencies of the case. The "great engineers" mentioned above promised that $4,500,000 would cover development and equipment costs, including a 6,000-ton mill; but inside of four months after making that declaration, we hear it told that the company is contemplating the early issuance of new stock at $20 or $25 a share, to back a convertible bond issue.

Now this makes it plain, does it not, that the public did not take the original stock to any appreciable extent, and that if $4,500,000 was raised it came from insiders. If that is the case, what is more natural than that the gentlemen who have thus far been taking care of requirements should still want their money back and what is more natural than to "sand-bag" the public for it?

Within the next ninety days we expect reports from Alaska Gold Mines promoters to show that the Sheep Creek tunnel has demonstrated that the Perseverance ledge—originally thought to have been the chief ore-bearing channel, is nothing more than one of the lines of demarkation to an ore-bearing zone amounting to practically "a mountain of gold," and that the gullible Thompson-Towle outfit will be used to diffuse that information and help round up the public's coin in exchange for convertible bonds.

[Note.—Since the above article was written the subsidized press has actually commenced likening the Alaska Gold Mines to the Utah Copper.]

A facetious member of the staff of the New York Sun has asked why Mr. Untermyer, who is conducting the money-trust investigation for Mr. Pujo, does not put himself on the stand and ask himself to explain all the details of the Utah Copper-Boston Consolidated amalgamation.—"By the Way" man in E. & M. Journal.

Tin has been discovered in the province of Alacania, Chile.

. NEWHOUSE GOES ABROAD

er about two years of involuntary e on his part and an almost cruel rawal of his publicity agents, an- ement was made early in the h that Samuel Newhouse was leav- or Europe, where, he would spend ple of years in rest and recupera-

w time flies! And what mighty es are wrought in the sweeping by e allegorical character symbolized e hour-glass and scythe! How pitt- s fate; how unrealistic is the glare modern "spot-light," and how deep be the gloom one feels when that is shattered and the realization that a selfish world no longer ips!

passing of Samuel Newhouse the stage of mining promotion ac- s and the field of business enter- in which he swirled with such daz- brilliance for a few brief years rs on the tragic. He shot into the ment of fame like a rocket, spent orce, exploded in mid-air, and then ivion enveloped him, and the world t. His rise furnished material for ands of pages of worldly news- comment and sycophantic lauda- his descent and exit has brought no words of comfort or even re- from his erstwhile friends. Why is

Newhouse's career as a mining oter and "magnate" was, for a most successful. Glancing back the record and comparing it with y now being made along similar and with even more lavish and ex- gant detail, the thought will not that other "master minds" in the lative mining world also are head- heir crafts direct for the sea of ob- and the ragged shoals of "invest- ruin. Like Newhouse, they per- y may retire in comfortable cir- ances, but their gain will only add e wreckage strewn along the path se who follow them. To those who take the lesson home it should be necessary to call attention to f the schemes worked by New- in order that it may, by inference. ast, be compared with others of greater magnitude and boldness being perfected for those who are lently counted upon to follow y the "bull" leader in his march to laughter house.

Newhouse accumulated not a little money through the exploitation of ewhouse Mines and Smelters, and of it came out of the pockets of people. Thousands vividly recol- ow Mr. Newhouse flew across the ent and landed here just in the nick of time to rush to the bank and plank down $200,000 on an option that covered the chief property in Beaver county that was to form the basis of the corporation. Then followed the or- ganization of the company, the equip- ment of the mines and the building of mills and power plants; the purchase of springs and the installation of water works; the building of the town of New- house, with its modern club-house, to- gether with a railroad from Newhouse to Frisco, so that no impediment should be placed in the way of the prompt op- ening up of the mammoth orebodies and the marketing of the product. The old mine workings were connected through a long, new operating tunnel, when it was quickly discovered that acres of copper ore broke through to the surface. This ore could all be scooped up with steam-shovels, dropped down through the shaft and loaded in trains at the tunnel level and from there be sent di- rect to the mill. Through the inaugura- tion of this scheme Mr. Newhouse be- came the pioneer steam-shovel miner of copper ore in Utah.

Samuel Newhouse.

Following this loudly and widely her- alded preparatory campaign came that of the real business—the manipulation of the stock market and the unloading of insiders on the public. Everybody re- members what happened to them, even if they don't know just HOW the scheme was worked. The mine developed in a "phenomenal" manner; there was strike after strike and reporters, stock brokers and the public was loaded to the guards daily—often hourly—with the latest re- ports from the property, the press no- tices being usually accompanied by a photograph of the promoter. It was glorious! Finally the market price of the shares began to climb, then to soar, and everybody made money—on paper.

To help out the situation the price of copper metal also began to soar, so all hands loaded up with Newhouse Mines and Smelters stock. The boom started around $4 a share and it broke at about $26. The public got in at about $9 a share up. Mr. Newhouse was reported as having reluctantly surrendered 100,000 shares of his personal stock in one block to French investors at about $20; it was just like making the Frenchmen a pre- sent of about $20 a share; he was mor- ally certain that the stock would go to $40, because it was worth much more than that.

Well, it was not long until the public became inquisitive, if not suspicious, and wanted to know more about the value and extent of the orebodies in the mine, the character of the stuff being milled and the recoveries made. Committees of stockholders were frequently organized to visit the mine and see for themselves, and—as most of them knew little about mining and the reduction of ores—it was not hard to "show them" what a big thing it was. These committees usually returned greatly elated by reason of what they had been told and "shown" and—bought more stock. The price of copper metal, which had touched 26c., then began to recede as if in an effort to keep pace with the decline in New- house shares, already started. Then came the effort to stem the tide of the receding current by the announcement that the company would begin paying regular dividends in the immediate fu- ture; but the thing was top-heavy, and soon the inevitable reaction set in. The decline was gradual at first, but cer- tain. While the "investors" were pa- tiently waiting for the dividend period to open insiders were "shorting" the stock and making additional large pro- fits, because they knew what mine con- ditions were and that the $300,000 with which to pay the initial dividend would have to be borrowed. Hundreds of peo- ple here in Salt Lake paid from $16 to $26 a share for Newhouse stock, held it for dividends, received 50c a share and finally, later, were permitted to stay in and participate in the reorganization of the company on the payment of an as- sessment of $1 a share, half of which reimbursed the lenders of dividend money while the remainder provided a working fund for the new company.

The situation today is about like this: The old company was taken over by the South Utah Mines Company, which in- creased the original shareholdings of the Newhouse Mines from 600,000 to 850,000, par $5. The new company nego- tiated a bond issue of $1,000,000, con- vertible into stock at par and $800,000 was used to retire the bonds of the old

company; the remainder, as we understand it, to be used in so equipping the property that it might be made self-sustaining.

It should here be mentioned that in a previous issue of this magazine it was shown that of the entire volume of ore passed through the mill under the Newhouse regime there was an actual loss on operating account of 68c a ton, in addition to the entire loss of the output of the mill and mine. Subsequent reports of the South Utah Mines Company show that the same practice and loss has continued and that, in this manner, has been absorbed and wasted the entire working capital of $260,000 left over from the $1 assessment of the old company.

The old company never was able to earn a dollar, and it is evident that the new one is now face to face with the futility of the struggle and is ready to quit. It is hopelessly in debt and the holders of the "convertible bonds" begin to appreciate that these new-fangled modern "securities" are possibly not always what they seem.

It is not believed that many of those who acquired an education in high finance mining through their connection with Newhouse propositions are taking much stock in the more nearly up-to-date schemes of Newhouse imitators; nor should it be required of us to warn anybody that the Newhouse schemes were as kindergarten performances when compared to games now being played.

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"SMOKE NUISANCE" COMMENT

Ed. Mines and Methods: Remembering Salt Lake City only as it was in the seventies, especially as I saw it, usually in April, hidden under clouds of peach and apricot blossoms with the pure, undefiled breezes sweeping over it, amidst the clear Western sunshine, your article on the smoke nuisance comes as a shock to me. It is indeed a calamity to have so beautiful a city as Salt Lake then was—a joy to the beholder—turned into a "modern city."

My object, however, in writing is to call your attention to something that will mitigate a part of the nuisance. Nothing but rooting out the smelters will prevent the gases from their furnaces which are far more objectionable than the visible smoke, but the smoke from power plants or all plants where coal is burned on boiler grates can be entirely done away with by the use of a new system of burning coal, the use of mechanical draft and of the Grieve grate, which Mr. Albert Richter, an engineer of your city, can give further information on. This grate simply produces perfect combustion—an incandescent, smokeless fire—and in its turn produces a very great economy in fuel, rarely less than 20 or 25 per cent and often more, so that an installation is earned in the superior economy usually in from one to three months, depending on now many hours a day the plant runs. None of these grates have yet been installed, but why is not this feasible? Two or three interested parties find some one who can install and prove these claims and when you are convinced—as you will be—that smoke cannot only be prevented but doing so will be an investment for the owner of the check book that pays for the coal of several hundred per cent per annum, then pass a stringent smoke ordinance and if necessary shut up plants that continue to be a nuisance.

The grate in question has only been on trial for four years and only last fall put on the market; but aside from fuel economy has shown such merit that it is being bought where coal has practically no value, such as the culm at the mines. Such concerns as the Standard Oil Co. have many hundred of them in their refineries, while the Corn Products Co., American Sheet Tin Plate Co., American Steel & Wire Co., and any number of other large and well managed concerns are using this grate. I could enumerate numbers of equally important buyers, but mention only a few to explain that this is no fad or untried thing. I want to add that I have not a cent's worth of interest in whether they are sold or not in your state; but once convince one or two of the right kind of people what this means and self-interest will make the fight an easy one.

The owners of the large dry goods and mercantile establishments lose annually enough in value of merchandise so they could afford to equip every plant in the city.

I am very much interested in Mines and Methods, although not a miner, and have several times had occasion to warn others as the result of what you have cautioned your readers to beware of.

Yours Truly, CHAS. L. MANN.

Milwaukee, Wis., January 21, 1913.

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Copper producers have relieved themselves of the strain they professed to be making to prevent "a run-away copper metal market" by lowering the price more than a cent a pound. It is now in order for the manipulators of Utah Copper to begin explaining how much easier it will be to increase dividends with the metal at 15c or 16c than it would have been had the price been held at 17¾c or advanced to 20c. Geo. L. Walker probably can make the "argument" as well as anybody.

Cable advices received from Chile, says a New York publication, state that important development work has been done at the Braden mines recently. In the Teniente mine an extensive deposit of copper ore has been uncovered, averaging 5.35 per cent. copper, as compared with copper ore mined recently at 2.70 per cent. The mineral separation plant which has been put into full operation within the last few weeks, has shown a recovery of 81.60 per cent of copper, as compared with 62 per cent of recovery in the old mill. In the early part of next year the Braden company will have its full equipment in operation, and engineers and officers of the company claim that from 45,000,000 to 50,000,000 pounds of copper a year will be produced with the present equipment in full operation.

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This sixty-two per cent recovery mentioned is what was obtained by methods paterned after Utah Copper. The difference is practically twenty per cent in favor of the new process; and still there is daily exploitation of the "perfection" of the methods employed by the engineers of the "low-grade porphyries" companies—Utah Copper, Ray, Chino and Nevada Consolidated. According to the above item concerning Braden, the other companies mentioned might just as well be recovering one-fifth to one-quarter more copper than they are doing at present. In other words Utah Copper, for instance, is WASHING AWAY into the tailings ponds about ONE-HALF AS MUCH COPPER in a year as Braden makes. The wonder is why do the Guggenheims stand for it!

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Commenting on a statement that "Producers are endeavoring to supply the current demand for copper without a further advance in price," the American Metal Market Report recently observed: "This last statement seems a strange one to make. To most of the trade we think the impression is that the producers are not trying to stop prices from further advancing, but trying to stop prices from declining, as a result of the certainty of larger increased stocks to be shown in their next statement and the threatened situation abroad. This, however, is no criticism on the power of the producers to hold prices from declining. We believe this is something that is easily in their power for some little tome to come, irrespective of developments."

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After three months devoted to pressing professional work Mr. W. L. Austin is again taking up the presentation of his papers on "Leaching Applied to Copper Ore." His article intended for this issue, however, arrived too late to meet the necessities of press runs and must go over to next month. The forthcoming articles of the series will deal largely with features of the practice and art as it exists today, and that they will be found highly educational and intensely interesting to the profession there is no doubt.

TUATION INVOLVING BUTTE AND SUPERIOR

e consternation occasioned during arly part of this month by the "unng" of large blocks of Butte & rior stock on the eastern market eputed inside interests resulted in s and Methods making a thorough tigation into the causes for the mentioned. The results obtained the investigation made at the prop- in part, briefly outlined in the folg paragraphs, are based upon l facts derived from a personal exation by a member of the staff. We publish much data on the subject is time but primarily the intent of paper only is to outline in brief the nt features and present to those y interested in legitimate mining ers the true situation. We prefer readers draw their own respective lusions from what is here outlined, therefrom they can readily appre- the conditions existing at the Butte uperior property under the present agement, which is representative of conditions existing at every prop- in which the Utah Copper interests the dominating factors.

ference has been made from time ime in the columns of Mines and ods to the remarkable occurrence of ore at the Black Rock mine in the e mining district, Montana. The erty is controlled by the Butte & rior Mining Company which has oughly prospected the orebody durthe past several years and is said ave resulted in the development of rge tonnage of ore reported to carry average mineral content per ton as ws: Zinc, 17 to 23 per cent; lead, 1 per cent; iron, 2 to 3 per cent; magse, 2 per cent, and copper, 0.3 to 0.5 cent. It will be noted from the foreg that the ore is of simple charac- and of unusual grade. Contrary to y market reports the ore is not in e true sense of complex character, should yield readily to established ods of ore-dressing.

e Black Rock mine, more commonly ed the Butte & Superior, is not ny means a recent discovery, but been a producing property for sev- years, during which period it has operated profitably though on a l scale. However, the profits de- from the operation of the mine , in a great measure, utilized in the er development of the property is said to have been accompanied by successful results, as outlined by the present available tonnage of ore.

In the early history of the company financial conditions were such that the construction of a concentrating mill near the mine was a matter beyond even a remote consideration. Further, the development at that time did not warrant the erection of a mill in anticipation of underground mining development. Consequently arrangements were perfected whereby the old Copper Basin concentrator was acquired, and while the equipment was not especially adapted to the treatment of zinc ore, the engineer engaged by the company to superintend the milling operations ably arranged a plan of concentration which, in point of efficiency and economical operation, was very satisfactory; particularly as the plan considered only the antiquated equipment of the old concentrator, together with a few makeshift machines requisitioned into service.

This improvised plant was used for a considerable period of time, and beside operating to a profit, served a useful purpose as an experimental station wherein to work out a plan of efficient and economical concentration of the ore for future use. Exhaustive tests having been made at the old Basin concentrator under actual operating conditions over a long period of time an efficient and economical flow-sheet was determined which would effect an extraction of eighty per cent of the zinc mineral contained in the ore to be treated.

NEW FINANCING.

In view of the developments at the mine, and the need of a new concentrator nearer the mining property, the management entered into negotiations with Hayden, Stone & Company, through the dominating interests of the Utah Copper Company for the further financing of Butte & Superior, primarily for the purpose of securing money from the public with which to construct a fully equiped and modern milling plant based upon the best practice at Basin. The negotiations resulted in the stock control of the company passing into the hands of Hayden, Stone & Company, and the Utah Copper interests. The property thereafter entered the field more as a stock market issue than as a legitimate mining promotion, and naturally Mr. D. C. Jackling was appointed managing director of the company.

Capital for the construction of a new concentrating plant having been supplied by the public, the concentration engineer who had so successfully operated the Basin mill with good results under the most adverse conditions, was instructed to design a new concentrator the flow-sheet to be worked out upon the lines of the treatment which had proved so highly efficient and economical at the old Basin concentrator, and to submit the plans of the proposed new plant to Managing Director Jackling.

In compliance with this instruction a new concentrating mill of two 600-ton units was planned, designed, and completely built and equipped, all with the absolute approval of Manager Jackling. This new mill considered a treatment plan which had previously been worked out under actual operating conditions, and that readily would effect an average recovery of eighty (80) per cent of the zinc mineral in the ore to be treated, when operations were conducted on a basis of unit normal tonnage. In design and equipment the new mill was a credit to the constructiion engineer. Further it was fully adapted to at once fulfil its requirement, and was designed not only to treat the unit normal tonnages and effect a maximum recovery of the zinc values, but could perform its duty under constant operation, without any necessity for remodeling.

Immediately following completion the new concentrator was prepared for a trial run, so that the numerous mechanical difficulties attending the starting up of new machinery could be remedied. The only obstacle in the way of trying out the ore-dressing efficiency of the concentrator was a shortage of water. However, in view of this last named adverse circumstance, arrangements were made so that the jigs treating the coarse feed, and which were an essential part of the milling equipment of the unit, would be eliminated from the test, as water for only a portion of the unit was available. Therefore, the concentrator was started only in part, and operated for a period of about twenty hours, during which time, however, the efficiency of the equipment was demonstrated to perfectly fulfil every requirement, though the run was not representative of what would have been accomplished had every section of the unit been placed in operation. Notwithstanding the curtailment of operations, that portion of the equipment operated during the trial run clearly indicated that its complete unit efficiency readily would afford a general average recovery of eighty per cent of the zinc mineral contained in the ore to be treated, providing the entire equip-

ment was operated in unison and conditions normal generally.

REMODELING OF MILL BEGINS.

At this point in the operations a peculiar circumstance intervenes which is especially interesting in view of that which has been stated hereinbefore regarding the authority for, and approval of, the original mill design and construction. Messrs. Jackling and Janney, after the above mentioned indicated efficiency of the concentrator on the very brief test mentioned, promptly decided that the mechanical arrangement of the new plant did not conform to the popular standard.

They thereupon immediately proceeded, under the supervision of Mr. Janney to remodel section 1 of the mill, which they completely rebuilt in accordance with the general flow-sheet plan prevailing in the Utah and other mills under their supervision. Section 2 at present is being stripped of its original equipment preparatory to a duplication of the remodeled unit 1. By the time the remodeling of the second until shall have been completed the same course shall be followed as that which has prevailed at the Utah Copper, Chino Copper, Ray Consolidated Copper; that is, section one will be in line for further modeling of that remodeled section, and so on, ad infinitum.

Before treating the subject in detail attention is called to the fact, as hereinbefore stated, that Manager Jackling had approved the plan, design, and construction of the original new Butte & Superior concentrator (which was based upon the best practice at the old Basin mill), and immediately following its completion and initial trial run, had condemned the flow-sheet as inefficient, and at once ordered the concentrator stripped of its original equipment, and rebuilt along the lines of the remoledel Arthur plant of the Utah Copper Company. There is a reason which will be apparent to readers when they have carefully read the following paragraphs. Incidentally it is an explanation of the present ruling stock market situation which has brought about the disposition of large issues of stock from reputed inside interests.

The mechanical inefficiency occasioned through the remodeling of the new Butte & Superior concentrator perhaps is best illustrated by a strict comparison of the results obtained through the operation of the remodeled mill, and those resulting from the operation of the old Basin mill, at while latter place no pretence was made that mechanical perfection was, or could be attained in view of the many adverse conditions under which operations had been conducted. Let it suffice to state, however, that an ore-dressing expert had charge of the Basin concentrator, a fact that will be more pronounced when a strict comparison of results is made between the two milling plants. On the other hand Manager Jackling and has associates had claimed also the adoption of their ideas of ore-dressing the zinc ore from the Butte & Superior mines would result in the recovery of 80 to 85 per cent of the zinc mineral contained, besides greatly increasing the tonnage handled. The circumstances demand a comparison of the results obtained from both the old Basin mill and the recently remodeled Butte & Superior mill.

TABLE OF COMPARATIVE RESULTS.

Milling Plant	Month	Tons Ore Milled	% Zinc heads	Tons Concentrates produced	% Zinc in Concentrates	% Zinc recovered	Cost per ton Ore Milled
B. & S. Remodeled Mill	Nov. 1912	12,339	19.1	2,808	46.8	56.7	$3.65
Old Basin Mill ...	Nov. 1911	13,010	22.0	3,000	50.1	60.5	$1.98
Difference	....	−671	−2.9	−192	−3.3	−3.8	+1.67
B. & S. Remodeled Mill	Dec. 1912	16,436	18.9	4,058	46.2	60.6	$2.89
Old Basin Mill ...	Dec. 1911	16,890	20.9	4 315	50.2	61.6	$1 92
Difference	....	−454	−2.0	−257	−4.0	−1.0	+0.97

COMPARISON OF MILLING RESULTS.

For convenience the table given herewith clearly outlines the results obtained at the old Basin mill during the months of November and December, 1911, and those of the remodeled Butte & Superior mill during the months of November and December 1912. The figures given were in both instances derived from the company's records and therefore represent the actual operating conditons during the periods mentioned.

It will be noted from the table of comparative results given above that the remodeled Butte & Superior mill under its direction by Manager Jackling has failed in several vital particulars. Further, no evidence of increased unit tonnage treatment, or the promised high percentage recovery of the zinc content of the ore is apparent on the company report given above, though the mill has now been in operation under the new process for more than two months.

Stockholders in the Butter & Superior Company need not anticipate that a maximum percentage extraction of zinc mineral will ever exceed the December, 1912, figures until the present management shall return to the safe and sane methods of operation as embodied in the concentrator as originally constructed. It is quite certain, however, that increased unit tonnage at the expense of serious loss of mineral will be a predominating feature of the milling operations at the plant in the future, and for the benefit of those who are not conversant with the plan of treating tonnages of ore far in excess of rated mill capacity, it should be remembered that, for every per cent increase of tonnage treated over normal unit capacity there is a resultant loss occasioned which bears almost an inverse ratio to the percentage of excess ore treated.

In this connection it is pertinent to observe that the highest estimate made by the able engineers who have calculated the total actual tonnage of ore of commercial grade developed does not exceed two million (2,000,000) tons, which, at the normal rated capacity of the present Butte & Superior concentrator (1200 tons daily) affords supply for less than five years. Further, the former management during the progress of prospecting the territory controlled by the company exercised every possible means of locating additional ore-bearing areas by running long drifts with their attendant crosscuts from the various levels of the mine, but without successfully encountering any material of even remote commercial value. In fact, the orebody as at present delimited apparently outlines the extent of the deposit, and any further prospecting, either with depth or laterally holds no hope for the future. Possibly, therefore, the knowledge of these facts had some influence upon the action of Captain Wolvin to induce him to depart with his shares of stock in the company as recently reported from the eastern stock exchanges, and that the liquidation of his interests was not altogether involuntary.

COMPARATIVE OPERATIONS.

A brief resume of the comparative operations of the old Basin mill and the recently remodeled Butte & Superior mill is shown in the table to more clearly outline the discrepancies of the new plant operated by the Jackling management. Firstly, a comparison of the November, 1912, operations of the newly remodeled Butte & Superior concentrator is made with the November, 1911, operations of the old Basin mill. It will be noted by referring to the table that dur-

ing the month of November, 1912, the Butte & Superior concentrator treated 12,339 tons of ore averaging 19.1 per cent zinc from which 2808 tons of concentrate were produced having an average metallic zinc content of 46.8 per cent representing a maximum recovery of zinc mineral from the mine-run ore of 56.7 per cent, at a milling cost of $3.65 per ton of ore treated. During the month of November, 1911, the old Basin concentrator milled 13,010 tons of ore averaging 22 per cent zinc from which 3,000 tons of zinc concentrate were produced, having an average metallic zinc content of 50.1 per cent, representing a maximum recovery of zinc mineral from the mine-run ore of 60.5 per cent, at a milling cost of $1.98 per ton of ore treated

Therefore, it will be seen that the results obtained at the Butte & Superior mill when compared to those obtained at the old Basin mill show (1) that during the respective months of operation the old Basin mill handled 671 tons of ore more than the Butte & Superior plant: (2) produced 192 tons more concentrate, each ton of which contained 66-lbs more zinc per ton; (3) the percentage recovery represents an extraction of 16.76 lbs. more zinc per ton of ore treated, and (4) finally, the milling cost per ton of ore milled was $1.67 less. A similar comparison can be made concerning the operations for the months of December, 1911, and December, 1912, by the old Basin and the new Butte & Superior mill, evidencing throughout the higher efficiency of the former.

That a new mill, recently remodeled along the lines of the Arthur plant of the Utah Copper Company, and designed to recover 85 per cent of the zinc mineral contained in the crude ore should suffer the relapse noted from the report shown (although nursing was a particular feature of the operations throughout) and demonstrate its maximum efficiency by recovering but 56.7 per cent of the zinc mineral treated is deplorable.

Now, carefully compare the results obtained from the new mill in 1912 (as outlined in the table) with those resulting from the operation of the old Basin mill during similar months in 1911, and draw your own conclusions. Incidentally it might be advisable to compare these results with what is found in the market letters of the brokerage houses representing the Jackling interests, and also the reports made by the gentlemen who renovated the Butte & Superior mill.

Referring to the comparative milling costs for the months of December, 1911, and 1912, it will be noted that the cost in December, 1912, was reduced from $3.65 for the preceding month (November, 1912,) to $2.89. In explanation of this peculiar feature it is proper to state that the reduction in cost per ton of ore milled from $3 65 in November, 1912, to $2.89 in December, 1912, was accomplished merely by charging off to construction the difference of $0.76. In view of this evasive practice of substituting operating costs as outlined (transferring same to either construction or capital accounts) it is to be expected that within the next few months Butte & Superior will be producing zinc for nil.

Another interesting item considers the water supply for the mill. Water has always been a precious commodity at both the old Basin mill and more especially at the Butte & Superior mines where the new mill is located. Consequently, in view of the recent extensive operations, a considerable increase in quantity of water has been required and negotiations were closed with the city waterworks for the required supply. The result of this arrangement for the month of December, 1912, has been that the water for the milling operations of one 600-ton section (the other section not having been thoroughly remodeled) cost the company $5,690, in addition to the fixed charges for the water recovery plant at the concentrator. When the other section of the concentrator shall be placed in operation there will necessarily be a corresponding increase in the expense of water supply, all of which is equivalent to a very satisfactory profit in itself.

The foregoing may serve to indicate a reason for the recent heavy selling on the New York market by the controlling interests—other than those represented by Captain Wolvin as before referred to. On this occasion at least, the Jackling management has run up against a real mining and milling project which will not countenance amateur experimental milling. In short they have acquired a property that requires engineers to handle, and not a crew of gentlemen with ideas which ignore established mining and milling practice.

In conclusion our contention is that under the present management the property is being used primarily as a stock-jobbing scheme, which every move thus far made clearly proves. Further, we know that the engineer who designed and built the original Butte & Superior mill was thoroughly conversant with every requirement of the situation, and, moreover, that his plans were endorsed by Manager Jackling; also, that had the original mill been permitted to operate the results obtained would have met all reasonable expectations and the property would have come into its own Thus it would have become a highly profitable producer, though evidently not upon a scale to support inflated stock market quotations.

DEATH OF PROF. KOENIG

Inexpressibly shocked were the local graduates of the Michigan College of Mines when the wires announced, on the 15th of the present month, that Dr. George Augustus Koenig, the noted chemist and scientist and dean of the department of chemistry, had died the night before at the home of his son in Philadelphia. Dr. Koenig's last trip to the West was made during the summer of 1910, when he came out here to make a scientific investigation of the Utah-Wyoming phosphate deposits in the interests of Messrs. M. S. Duffield and L. A. Jeffs, who have, since that time, cleared up their titles to a large portion of the phosphate lands in the region mentioned We excerpt the following from the Houghton Gazette's mention of the famous educator's death:

George Augustus Koenig was born at Willstatt, grand duchy of Baden, Germany, May 12, 1844. He was the son of Johannes and Margaretha Pfotzer Koenig. His primary education was gained in the public schools of Willstatt. He studied at the progymnasium at Kork from 1854 to 1857 and during the ensuing two years at the Moravian Bros.' school at Lausanne, Switzerland. Graduating from the polytechnical school at Karlsruhe in 1863, with the degree of mechanical engineer, he entered Heidelberg university and remained there a year, later taking the degree of master of arts, 1867, at the University of Berlin after two years of study. He spent the year 1867 at Heidelberg, taking the degree of doctor of philosophy, and spent the next year at the mining academy of Freiburg, Saxony.

Dr. Kroenig's greatest achievements as a scientist was in the field of new minerals. He discovered no less than thirteen hitherto unidentified minerals, the following being the list: Hydrotitanite, randite, Leydite, Alaskaite, beergerite, bementite, footite, paramelaconite, mezapilite, mohawkite, keweenawite, stibiodomykite, melanchalcite.

Dr. Koenig re-examined many known minerals and shed new light on their origin and structure and he was the discoverer of the fact that the diamond occurs in meteoric iron.

Dr. Koenig easily was the most popular professor ever connected with the Michigan College of Mines. His many years of residence in the United States had not eradicated entirely the traces of German from his spoken utterances. He realized that this characteristic sometimes gave the students occasion for laughter and he always joined in it gladly. He had a kindly humor and his lectures always were illuminated by gentle fun so that his classes were never irksome to the students. His kindliness was felt by every student and by everyone else with whom he came in contact, professionally and socially.

A Boston market letter, dated January 9, says: "Alaska gold has offered a very attractive market for traders. It has been tipped for $20, and evrybody has the tip. That being the case, it would seem as though somewhere between $14 and $15 would be a safe place to get off." So you see that even Boston brokers, wise to the business, consider this "security" as nothing more than a football for "traders."

UTAH METAL PRODUCTION FOR THE YEAR 1912

The ore production of Utah in 1912 aggregated close to 7,500,000 tons, valued at about $44,000,000 for its gold, silver, copper, lead, and zinc content, or an increase of 19 per cent, according to preliminary figures by V. C. Heikes, of the United States Geological Survey. The strike of miners at Bingham, lasting forty days, during which nearly all the mines there were closed or operating with decreased forces, caused a decrease of about 500,000 tons in the total ore production. The smelters, however, were not seriously affected, as they operated for a time on the stock reserves and at nearly full capacity the entire year. Owing to the higher price paid for the metals, considerable old mine dump material on various properties, the accumulation of many years' operations, was almost entirely disposed of to the smelters and likewise large dumps of old slags were shipped for re-treatment without sorting. The Bingham camp was credited with an ore output of slightly over 6,000,000 tons in 1912. The Utah Copper property alone yielded approximately 5,520,000 tons, which was an increase of about 15 per cent over the 1911 production. From mines in the Tintic district an increase of 14 per cent in the ore production gave a total output of about 400,000 tons, which was mined from the Centennial-Eureka, Iron Blossom, and thirty other mines. The tonnage includes much low-grade dump material and about 8,000 tons of zinc carbonate and slicate ores averaging about 34 per cent of zinc from ten mines, which will likely continue to ship during the year 1913. Although it was previously known that zinc ore existed in the Tintic mines, it was a surprise to many operators to find such extensive bodies of the ore in the old lead-ore stopes. At Park City the ore output was about the same as in 1911 and aggregated 296,000 tons, of which 42,589 tons were shipped direct to the smelter and the remainder milled, producing about 43,000 tons of lead and zinc concentrate.

The total gold output was about $4,300,000, a decrease of eight per cent from the 1911 production, due principally to the greatly diminished output of the Mercur mines and to the smaller shipments of siliceous ores produced from mines in the Tintic district, where plans are under way for a large cyanide plant to treat the ores of several of the properties.

Silver contained in ores produced in 1912 aggregated about 13,000,000 ounces, this production being about 4½ per cent greater than that of 1911. The increase was probably due to increased shipments of lead ores mined in the Tintic district and from lead concentrates produced in the Park City region.

The copper production of 1912, amounting to nearly 150,000,000 pounds, was an increase of about two per cent over the output of 1911. The increase is credited chiefly to the Bingham district.

The lead output, aggregating about 140,000,000 pounds in 1912, was 2½ per cent greater than the output of 1911. The increase is partly accounted for by the fact that more lead ore was shipped from Tintic and more lead concentrates from Par City than in the previous year.

The production of zinc, figured as spelter, amounted to about 15,500,000 pounds and is about thirteen per cent less than the figures reported in 1911. This decrease is due largely to a falling off in shipments of blende concentrates from Par City. The new producers of zinc ore in the Tintic district were the May Day, Uncle Sam, Godiva, Gemini, Lower Mammoth, Yankee, Ridge and Valley, East Tintic Development, and New Bullion.

Dividends amounting to nearly $9,500,000 were paid from Utah mines during 1912.

THIOGEN PROCESS AND SMELTER FUMES

The smelters located in certain agricultural regions of the west, especially in California, have been operated under great handicap during recent years, or have had to suspend operations, owing to the hostile attitude of the agricultural population toward the smelter fumes, says the Mining & Engineering World. The smelters have gone to considerable expense and trouble to control the fumes and have succeeded as far as the solid matter is concerned. The non-condensible gases, of which sulphur dioxide is the chief troublesome constituent, have most persistently resisted efforts for their satisfactory control. A process that promises much has been devised by Prof. S. W. Young of Leland Stanford University. This is the Thiogen process for converting the sulphurous gases into marketable sulphur.

As mentioned in our columns several months ago, this process has been under test at the Penn Chemical Co.'s smelter at Campo Seco, Cal. The results are reported to have been very encouraging. The process is a chemical one, being a reduction of the SO_2 by passing it mixed with an oil spray and heated to about 800° C. over a mixture of plaster of Paris and sawdust (to give porosity) moistened with water containing a small proportion of iron salts. The volatilized reduced sulphur is passed into a condensing chamber where it is collected as yellow sulphur.

Should this process prove all that is hoped of it, it will be only another demonstration of the solution of a difficult problem forced by necessity. The Thiogen process aims not only to control the sulphurous fumes from roasting and smelting furnaces, but to yield a valuable product—sulphur—as well.

FREIBERGERS ORGANIZE

On Friday evening, December 20, at the Hofbrau-Haus, Broadway and Thirtieth street, New York City, a number of old students of the Freiberg Bergakademie sat down to dinner. This meeting was called for the purpose of forming an association in America to be known as the "Old Freibergers in America."

After the dinner a business meeting was held and the following officers were elected: President, R. W. Raymond, Freibergw, 1861; vice-president, Gardner F. Williams, Freiberg, 1868; and secretary-treasurer, C. L. Bryden, Freiberg, 1907.

It was decided to hold two meetings a year, one on March 25, the anniversary of the founding of the Akademie, March 25, 1765, and the other on the 20th of December, this to be the annual meeting.

The following members were present: Dr. R. W. Raymond, 1861; Gardner F. Williams, 1868; P. J. Oettinger, 1867; Stuart M. Buck, 1868; T. Waln Morgan Draper, 1876; Baron Alfred von der Ropp, 1882; Franklin Guiterman, 1877; F. G. Corning, 1879; R. Boice, 1908; Albert Meyer, 1908; R. M. Payne, 1909; Dr. E. E. Lungwitz, 1886; F. H. Sistermans, 1885; Geo. M. M. Godly, 1900; Walter V. Rohlffs, 1903; H. H. Knox, 1886; H. A. Wilkins, 1889; and C. L. Bryden, 1907.

All old Freibergers who have not already done so, are requested to send in their names and addresses to the Secretary, C. L. Bryden, 1015 Myrtle St., Scranton, Pa.

The value of the metal production of the United States in 1912 was $788,925,046, according to the U. S. Geological Survey.

WHO TAUGHT SALT LAKE CITY TO SMOKE?

Graphic Presentation of Data On a Subject of Vital Importance to Salt Lake People.

By J. CECIL ALTER.

That our once bright and clean maiden-like city should in her maturer years acquire the coarse and uncomely habit of smoking, and that to an excess verging on dissipation, brings deep regret on all her lovers; and in the evil of this sadness the admirers of this jewel city of the west are sending bitter hatred and complaint against every owner of every smokestack.

These complainants would have old laws enforced and new laws enacted; they would have violators of the Clean City spirit consumed in their own furnaces, as it were, including their smoke, feeling, as they seem to, that the large furnaces of the city are responsible.

And yet, amidst all this clamor, and against all the evidence showing that Miss Salt Lake is an immoderate coal smoker, it has been almost overwhelmingly proven in a careful and extensive investigation that if every fire in Salt Lake City had been extinguished eleven long years ago, and not a pound of any fuel had been burned here since that time, the dirty smokes and fogs that disgrace us would nevertheless have been more than seven times as numerous as in the previous eleven years with all the fires going; and proven also that coal consumption in the furnaces of the business district of Salt Lake City is next in smallness of importance to the actual tobacco that the men smoke on the street!

And however startling this announcement may be, it nevertheless will not be seriously questioned, even by the so-called smoke experts, after they have examined the records showing the length and date and density of the smokes and fogs which are maintained by the U. S. Weather Bureau in this city, in connection with the statistics of population and coal consumption growths. As shown by the accompanying fog-table, compiled from the government records, there was a total of 25 days on which a light or a dense fog or smoke occurred, during the eleven years ending December 31st, 1901; or an average of about 2 per year, and as most of us will well remember, those were wholesome halcyon days indeed for Salt Lake City, when the winds were welcomed only for what they brought and not at all for what they were able to carry away.

During the succeeding eleven years which ended with December, 1912, there was a total of 221 foggy or smoky days, an average of a trifle more than 20 foggy days per year, or just ten times as many as in the first eleven year period. The climate is not changing, for no meteorological element has changed appreciably except the density and length and frequency of the fogs and smokes.

Now the figures of coal consumption in this city as compiled in part by the State Coal Mine Inspector, have followed very closely upon the population values, which in 1910 were about 70 per cent greater than in 1900. From this information it is perfectly just—and no more than just—if smoke from chimneys is being arraigned for causing the fogs, to take the fog figures for the first eleven year period, add to them the percentage of coal consumption increase, and thus arrive at the fog figures for the second eleven year period. This would give a total of only 42 fogs, or just 3½ per year, though as we have seen, the records show that an actual average of 20 foggy days occurred instead of 3½, and that the increase in fogginess began promptly with 1902.

NUMBER OF FOGGY DAYS AT SALT LAKE CITY FOR TWENTY-TWO YEARS
(Including Dense Smoke. About half of these Fogs obscured view entirely beyond 1,000 feet; the remainder obscuring view beyond a half mile.)

Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
1891	..	..	..	..	..	..	..	..	..	..	..	..	None
1892	4	4	..	..	..	..	..	..	..	..	..	..	8
1893	2	..	..	..	..	..	..	..	..	..	..	..	2
1894	..	..	..	..	..	..	..	..	..	..	..	..	None
1895	..	..	..	..	..	..	..	..	..	..	..	1	1
1896	3	..	..	..	..	..	..	..	..	..	..	..	3
1897	..	..	..	..	..	..	..	..	..	..	..	..	None
1898	..	..	..	..	..	..	..	..	..	..	1	..	1
1899	..	..	..	..	..	..	..	..	..	..	..	2	2
1900	6	..	..	..	..	..	..	..	..	..	..	..	6
1901	..	1	..	..	..	..	..	..	..	..	..	1	2
1902	8	..	..	..	..	..	..	..	..	..	..	..	8
1903	7	6	5	..	..	..	..	..	..	..	1	10	29
1904	3	..	..	..	..	..	..	1	..	1	..	1	6
1905	1	1	2	..	..	..	..	..	..	..	4	14	22
1906	11	15	4	..	..	..	..	..	..	..	7	3	40
1907	11	3	2	..	..	1	..	..	..	..	7	1	25
1908	6	1	2	..	..	..	..	..	..	5	2	3	19
1909	1	6	..	..	..	..	..	..	1	5	4	2	19
1910	5	1	..	..	..	..	..	3	..	..	4	6	19
1911	2	2	1	..	..	..	..	..	..	..	..	4	9
1912	3	2	1	..	..	..	..	..	..	1	2	16	25

FACTORY AND RESIDENCE SMOKE.

Now before we call in the astronomers to explain just what great sidereal or celestial readjustment took place in 1902 that might cause this increase in fogginess and smokiness (which by the way occurs almost exclusively in the winter time) let us get away from the peculiar illusion of the senses and tradition that the large furnaces are so gravely responsible; how often have we all had a large black cloud rolling away from a chimney top pointed out to us with the remark, "There is the root of the smoke evil," and yet, I repeat, these very volumes of furnace smoke from factory, apartment house, skyscraper, department store, and engine are the very least in importance in considering the fog or smoke nuisance in Salt Lake City, and in almost all cities as well, for that matter.

The compilations of the coal companies, which tally perfectly with the shipping statistics of the railways, show that on the average about 80 per cent of the coal used in Salt Lake City is lump coal, and 20 per cent slack and mine-run. The lump coal is used in the household stoves, in the residence section, the slack is used in the furnaces, and the mine run in the railroad engines and yards. A little fine coal goes to the residence district but it is just about offset by the amount of lump coal that is used down-town, so that, from incontrovertible direct evidence, we find the "big belching stack"

to be responsible for but one-fifth of the trouble; and on closer technical examination we find this figure far too great, for, with automatic stokers, and professional firemen feeding the furnace fires, all scientific writers and studious engineers are agreed—there are no dissenters—that the wasted fuel is much greater among the households, where practically all coal is top-fed on a draught that carries the disintegrating but unburnt coal up the flue into the air, than in the down-town furnace.

An engineer writing recently for the new edition of the Encyclopedia Britannica says the down-town furnace, even with modern appliances, uses on the average about twice as much coal as is necessary, and that the consumption in the residences is six times as great as necessary! And from this evidence we much swifter winds at the greater altitudes, and is thus sooner carried away; and several visits to the benches north and east of the city in the early morning before the city fires were built, from where the interesting smoke kaleidoscope could be watched, have shown conclusively that not only does the furnace smoke rise to about twice the height, (estimated at about 1,000 feet, of the mass of the residence smoke), but that its average texture from street to street is much less homogenous, and that, since it is higher it is carried away much more rapidly.

Of course only a swath of smoke from the residences (about three to five hundred feet deep estimated) as wide as the business district, flows across the business district, though the flow is continuous until the wind or the sun dissipates it; and of the actual smoke exist- directly by the smoke. An official investigation in London two years ago showed that 20 per cent of the London fogs were directly caused by city smoke, and that the duration and the density of all fogs were greatly increased; yet the greater part of fog, or the obscuration, was atmospheric moisture built up on the smoke particles. The smoke particles when thrown into the air lose their heat into space and become much cooler than the surrounding air in which they are moving, and a tiny globule of moisture—an actual fog unit—is condensed on the smoke particle or attached to it, thus making the foundation for the very worst kind of fogs.

When the smoke particles are not cooled by radiating their heat sufficiently to condense the moisture upon them from the adjacent air, the fog particles cannot

PREVAILING WIND DIRECTION BY HOURS, SALT LAKE CITY, UTAH.
(For Hours Ending At):

	1a	2a	3a	4a	5a	6a	7a	8a	9a	10a	11a	12m	1p	2p	3p	4p	5p	6p	7p	8p	9p	10p	11p	12m	pr
JANUARY.	SE	SE	SE	SE	SE	SE	SE	SE	SE	SE	SE	S	NW	NW	NW	NW	NW	NW	SE	SE	SE	SE	SE	SE	SE
FEBRUARY.	SE	SE	SE	SE	SE	SE	SE	SE	SE	SE	S	NW	NW	NW	NW	NW	NW	NW	NW	SE	SE	SE	SE	SE	SE
MARCH.	SE	SE	SE	SE	SE	SE	SE	SE	SE	SE	S	NW	NW	NW	NW	NW	NW	NW	NW	SE	SE	SE	SE	SE	SE
APRIL.	SE	SE	SE	SE	SE	SE	SE	SE	SE	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NE	SE	SE	SE	NW
MAY.	SE	SE	SE	SE	SE	SE	SE	SE	SE	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NE	NE	SE	SE	NW
JUNE.	SE	SE	SE	SE	SE	SE	SE	SE	SE	S	NW	NW	NW	NW	NW	NW	NW	NW	NW	NE	NE	NE	NE	SE	SE
JULY.	SE	SE	SE	SE	SE	SE	SE	SE	SE	SE	SE	NW	NW	NW	NW	NW	NW	NW	NW	NE	NE	NE	NE	SE	SE
AUGUST.	SE	SE	SE	SE	SE	SE	SE	SE	SE	SE	S	S	NW	NW	NW	NW	NW	NW	NW	NE	NE	NE	SE	SE	SE
SEPTEMBER.	SE	SE	SE	SE	SE	SE	SE	SE	SE	SE	SE	NW	NW	NW	NW	NW	NW	NW	NW	NE	NE	NE	SE	SE	SE
CCTOBER.	SE	SE	SE	SE	SE	SE	SE	SE	SE	SE	NW	NW	NW	NW	NW	NW	NW	NW	NW	NE	SE	SE	SE	SE	SE
NOVEMBER.	SE	SE	SE	SE	SE	SE	SE	SE	SE	SE	SE	NW	NW	NW	NW	NW	NW	NW	NW	SE	SE	SE	SE	SE	SE
DECEMBER.	SE	SE	SE	SE	SE	SE	SE	SE	SE	SE	SE	SE	NW	NW	NW	NW	NW	NW	SE	SE	SE	SE	SE	SE	SE

deduce, that there is three times as much smoke from a ton of coal burned in the residence as there is from a ton burned in the down-town automatically—or carefully-fed furnace. Therefore, out of every 100 tons of coal used in Salt Lake City, 80 tons of it (in the residence section) is producing 12 times as much smoke as the other 20 tons is producing down-town.

The big down-town furnace, with its picturesque smoke-trail is actually entitled to only one-twelfth the abuse that is heaped upon it, when judged by these figures. Yet, before leaving the furnaces to their calumniators, the further fact must be presented that the draught in the large stacks together with the greater heat of the smoke in them, are influences which carry the smoke much higher than the smoke from the residence chimney, and thus it more quickly reaches the ing in the business district at any one time after the great sea of residence fires is started, it is estimated that about two parts out of three of the total smoke are from the residence district, and, when considering the length of time residence smoke flows across the business section, as well as the density of this smoke, it is very conservative to estimate the residence smoke to be responsible for nine-tenths of the trouble; and this owing partly to the fact that the prevailing morning winds are from easterly or southeasterly directions, carrying great quantities of residence smoke across the business district.

SOURCES OF REAL TROUBLE.

But the mere smoke itself is actually not a very serious matter, but rather is it the resultant condition, namely, the "city fog" (a relatively dry fog) caused be produced, and such is the condition on the warm mornings in winter, nearly all of which are devoid of fogs; the cold mornings, especially when there is snow on the ground and the relative humidity is high, nearly always produce these smoke-built fogs. For this reason the same amount of smoke in summer is less obnoxious than in winter.

It is interesting to note what a quantity of solid matter, namely, carbon, sulphurous, mineral matter, etc., may be held in suspension by a good robust smoke-made fog, much of which is deposited on all surfaces in contact with the murk. Deposits have been measured as great as 22 pounds per acre; some of this we breathe, some we eat, some gets into our complexion, some into our clothing, and some into our household tapestries and furnishings. Ordinarily about 40 per

cent of the solid matter in the air is carbon; 35 to 40 per cent mineral matter; 10 per cent hydro-carbon, and small amounts of sulphuric acid and a half dozen other substances.

All of this dust would in a few hours float away to be heard of no more were it not for the formation of these dust-built and dust-entangling city fogs; and once a little fog is started the rest of the structure is rapid and continues until arrested by either the bright sun or a stiff wind. The condensing moisture not only increases the density of the fog but prolongs it a great deal, so that the moisture element alone is doubtless responsible for a very large per cent of the actual obscuration and filth distribution.

And right here we arrive at a most interesting fact; that there is a chemical element in the smoke, namely, sulphur, equal energy, so that in either case, the moisture-collecting, polluting, combination is formed, and the fog units manufactured and enlarged with great rapidity. It is often claimed by investigating physicists that the actual sulphuric acid is formed by the sulphur dioxide and trioxide appropraiting the additonal water and oxygen molecules, necessary, from the mere humidity, or the invisible gaseous water vapor in the air, thus creating the fog unit independent of those condensed on the smoke or dust particles.

A scientific writer, previously mentioned, writing for the new smoke article in the latest edition of the Encyclopedia Britannica, says of this phenomenon, "The combustion of coal is certainly responsible for their (London fogs) existence, but it is the sulphur of the coal (oxidized ultimately to sulphuric acid) and not the sorption from the air and thus intensifying the fogginess. There seems to be no escape from this conclusion: that sulphuric acid, sulphurous acid, sulphur dioxide, sulphur trioxide, etc., assist in condensing, or drawing the moisture from the air, especially when started by a dust-made cloud or fog unit, and the amount of moisture on winter mornings in Salt Lake City averages about 75 per cent relative humidity, which, surprising as this may seem, is a value only about 10 per cent below the humidity values in the Mississipi valley.

In one of the newer and more complete chemistry text books presented recently before the purchasers of the city's new school books, the interesting fact is stated, "On account of the energetic way in which it combines with water, concentrated sulphuric acid is used for drying

AVERAGE HOURLY WIND VELOCITY, MILES PER HOUR. SALT LAKE CITY, UTAH.
(Values Corrected to Homegenous Elevation of 190 feet above Street.)
(For the Hours Ending At)

	1a	2a	3a	4a	5a	6a	7a	8a	9a	10a	11a	12n	1p	2p	3p	4p	5p	6p	7p	8p	9p	10p	11p	12M
JANUARY.	5	5	6	6	6	6	6	6	6	6	7	8	9	9	9	9	8	6	6	5	6	6	6	6
FEBRUARY.	6	6	6	6	6	6	6	6	6	6	8	9	10	11	11	11	10	8	7	6	66	6	6	6
MARCH.	7	7	7	7	6	6	6	7	7	9	11	12	13	14	14	14	13	11	9	8	7	7	7	7
APRIL.	7	7	6	6	6	6	6	6	8	10	12	14	15	15	16	15	14	12	10	8	8	7	7	7
MAY.	6	6	6	6	6	6	7	6	8	10	12	13	14	14	14	14	13	12	10	8	8	7	7	7
JUNE.	7	6	6	6	6	6	5	5	7	9	11	12	13	14	14	14	13	11	10	8	9	8	7	7
JULY.	7	6	6	6	6	6	5	5	6	7	9	10	11	12	13	13	12	11	10	9	9	8	7	7
AUGUST.	7	6	6	6	6	6	6	5	5	6	9	10	12	12	12	12	12	11	9	8	8	8	7	7
SEPTEMBER.	6	6	6	6	6	6	6	6	6	7	10	11	13	13	14	14	13	10	8	8	7	7	6	6
CCTOBER.	6	6	6	6	6	6	6	5	5	6	8	10	12	12	13	12	11	8	6	6	6	6	6	6
NOVEMBER.	6	6	6	6	6	6	6	6	6	6	7	8	10	11	11	10	9	6	5	6	6	6	6	6
DECEMBER.	5	5	5	5	6	5	5	5	5	6	6	7	8	9	9	8	7	6	5	5	5	5	5	5

in various forms, which is one of the most hygroscopic substances known, and which draws every vestige of moisture to itself that it gets into contact with.

We have observed how foggy conditions are greatly intensified by the moisture condensing on the smoke particles, and this despite the fact that there is no special affinity between the smoke particle and the moisture particle; yet in the sulphur combinations emitted in all coal smoke, we have an element that instantly appropriates, chemically, every atom of moisture it comes in contact with, whether in vaporous or solid form. Sulphuric acid, a liquid in bulk at moderate temperatures, draws the water to itself; and sulphur dioxide, which is a gas, is drawn by the moisture particles (usually fog, or incipient cloud units) carbon, that is the active agent; and so long as coal is burnt at all, this manufacture of sulphuric acid and of fogs must continue. * * * The evil effects of town air on plant life and human lungs, often attributed to preventable smoke are due to this non-preventable sulphuric acid," going on to say that smoke consumers only burn the visible carbons, and that the sulphurous matter cannot be consumed or rendered harmless.

The sulphur content of Utah coal varies from 0.3 per cent to 1.0 per cent and the average of all coal used in Salt Lake City as shown by the records of the various fuel producers and the State Coal Mine Inspector is 0.70 per cent (seven-tenths) sulphur, all of which gets into the air through the chimneys to assist in collecting and accumulating the moisture by ab- gases"; thus showing its possibility as a drying agent for the atmosphere.

SMELTERS ARE GREATEST OFFENDERS.

And at last we reach the inevitable conclusion, the cruel fact we would avoid if we could, that the sulphur from the valley smelter stacks is responsible directly and solely for the production of 180 foggy days in Salt Lake City during the past eleven years in addition to the 42 foggy days we might have reasonably expected as previously indicated.

The ore handled in the valley ranges from no sulphur to as much as 45 per cent sulphur, if we may take the figures from court records, mine assayers and others more or less familiar with the facts, though a recent court decree requires that an average day's smelting

must not run above 10 per cent sulphur content. To maintain this average, low-grade sulphur ore is fluxed with ore running high in sulphur.

Assuming that the average can be kept as low as 10 per cent (which is not binding by the court on the Murray smelter), with an average day's business at each smelter, Murray and Midvale, of 1100 tons (the court permits 1,500 tons daily at Midvale) there is thrown into the air of the Salt Lake valley 220 tons of sulphur in some or all of its hygroscopic forms every day, or 80,300 tons a year.

Now there were 378,000 tons of coal used in Salt Lake City last year, averaging 0.7 per cent sulphur, or 2,646 tons of sulphur, which is just 3 1-3 per cent as much sulphur as was produced by the smelters!

Careful observations made at practically all hours of the day from Ensign Peak, Red Butte at For Douglas, and the foothills on both sides of the valley, as far south as the smelters, and at the Jordan Narrows, have shown that the smelter smoke is blown against every foot of mountain surface on all sides of the basin-like Salt Lake valley practically every day, and a thorough research into the wind records of he U. S. Weather Bureau show that usually there are no more than three days a month when the smelter smoke is not mixed over all parts of the valley daily as thoroughly as one could mix it in a bowl.

And since the greatest number of hours of wind is from southerly directions, the smelter smoke is almost continually lodged against this slope on which Salt Lake City is built, and therefore Salt Lake City suffers far more from smelter smoke than Murray or Midvale themselves, or any other community in the valley, the smelter fumes often accumulating in our end of the valley so dense as to obstruct the view entirely beyond a half mile.

The smelter smoke appears to offer more resistance than ordinary smoke and thus it hangs together better, so that nothing less than a fifteen-mile per hour wind can dislodge it from the valley completely and give us perfectly clear air, and this strong wind must continue three or four hours from a southerly direction, though a thirty-minute wind at that rate from the northwest will clarify our skies.

The smelter haze is ever present and ever visible in the valley and no matter how thin or attenuated, it is readily recognized by its color; and when blown in accumulations in various parts of the valley, it reassumes the distinctive whitish color it had when leaving the smelter.

The court restraining order, modified by Judge Marshall, requires the Midvale smelter to neutralize its sulphuric acid "by zinc oxide or other effective agent, so that no sulphuric acid shall exist in a free state in said gases." Now since sulphuric acid, chemically, is a molecule of sulphur trioxide SO_3, plus one molecule of water H_2O, equalling He_2SO_4, it is not quite clear just how any true sulphuric acid could exist as such, in stable compound, in any furnace, flue, or chimney, because the water molecule would be vaporized and separated from the sulphur in the intense heat, leaving only the trioxide, or most probably only the dioxide of sulphur. Of course no sulphuric acid goes up, but reversing the old adage, sulphuric acid does come down, for owing to the great affinity of all sulphurs for the water molecule, most of them are oxidized ultimately to sulphuric acid.

NO RELIEF IN COURT ORDER.

The court requires that no sulphuric acid remain "in a free state," (it must be neutralized, or have its teeth pulled, so to speak), so it cannot devour the screening bags in the bag houses, but it certainly is not required that the sulphur be annihiliated, nor is annihilation possible; the neutralization only changes its form chemically, and that only temporarily, it seems, and since all the forms of sulphur are hygroscopic, the moisture-grasping, fog-forming propensity is apparently not mitigated by anything that has been, or can be done, according to good authority. It is therefore possible that the court order is obeyed and that we get the sulphuric acid about the same as before, though our present concern is with sulphur in any form.

The order requires the operation of the bag-house to screen out all solid particles and of course the sulphuric acid would absolutely have to be neutralized, regardless of the court order, to prevent the bags from being literally devoured by the sulphuric acid; for the commercial value of sulphuric acid is largely due to its energy in attacking and decomposing almost everything with which it comes in contact.

The bag-house in good action gets most of the flue dust, and some of the so-called fume particles, but none of the gas, therefore the chimney discharge is mostly the sulphur dioxide, the unneutralized trioxide, and much fine dust (which is just as tangible in fog-making as any other fine dust), and the fuel gases including its hygroscopic sulphurous matter.

Most of the damage heretofore observed from the smelters was the injury to plants and animals caused by the dust and fume particles, but it is the gases and acids that are clogging the valley with fog and "smoke." The flue dust, which is not collected in a bag-house at Murray, is also very hygroscopic and absorbs moisture with great rapidity from the air, thus lending its assistance in the fog formation, in even a more effective manner than do the non-hygroscopic smoke particles that come from our furnace fires. The amount of flue dust, fume dust, and other dusts that goes up the smelter chimneys is enormous beyond ordinary comprehension; while 378,000 tons of coal were consumed in Salt Lake City last year, there were about 850,000 tons of ore, coal, lime, coke and other ingredients that are used in the smelter furnace charge, consumed during the same period, or 2¼ times as much solid matter as the coal in Salt Lake City amounted to. And the dust particles from this, cooling and attaching to themselves the moisture particles because of the mere condensation, this dust alone adds immeasurably to the atmospheric dust that assists the sulphur in the fog formation.

An estimate of the average amount of smelter smoke in the valley places it at 10 per cent or 15 per cent obscuration at 1,000 feet, ranging from none on days of long, steady, hard winds to 25 per cent or 35 per cent, or even 80 per cent in limited localities, or swaths, on quiet days, especially over Salt Lake City, where the "haze" is trapped in the curve of the hills. This value would be near to zero with our wind velocities if it were not for the fact that the Salt Lake valley rigidly confines the fumes. Small quantities of the fumes get over the mountains, and as has been indicated a wind of the proper strength and direction occurs only a few times a month.

At Great Falls, Montana, the world famous smelter stack rises higher than any other scenery for a long-wind-distance, yet with us in the Salt Lake valley the smoke never gets away with less than a fifteen-mile wind, and one that is maintained for some time, which is a very unusual occurrence.

The Salt Lake valley, because of its configuration, is probably the most logical place in the west for a beautiful city and a prosperous farming community; yet it is probably the most inappropriate place in all the world for an ore smelter, so far as the dust and fumes and gases are concerned.

WIND DIRECTION AND VELOCITY.
(December 11, 1912.)
An average day with fog, Salt Lake City.

1am	2am	3am	4am	5am	6am	7am	8am	9am	10am	11am	Noon	(Hrs Ending
SE	SE	S	SE	SE	SE	N	SE	SE	S	W	SW	(Direction)
2	4	5	5	5	3	1	5	6	3	3	3	(Mi. of wind)

Lt. fog 6a to 7:30; Dense, 7:30 to 8:30; Lt. 8:30 to 11 a. m.

And in closing, remembering that southerly winds blow over Salt Lake City at an average rate of six or seven miles per hour from 9:00 or 10:00 p. m. to 9:00 or 10:00 a. m. every day; and that our wretched reputation for smoke and fog dates abruptly with the year 1902, the further fact must be here recorded, that the Murray smelter activities date from the summer of 1902, the Midvale smelter began operations October 1st, 1902, and the Highland Boy smelter was in operation from May, 1898, to January, 1908.

It most certainly appears from direct and circumstantial evidence that it was the smelters that taught the young lady to "smoke."

EXTRACTING GOLD FROM GRAVEL DEPOSITS (III.)

By AL. H. MARTIN.

The elevator method of gravel mining dates back to early hydraulic-mining days in California. The warfare carried on by hostile interests against the hydraulic operator, largely because of deposition of tailings in beds of navigable streams, forced managers to provide for the stacking of gravel in such a way that its presence would not injure the suspicious farmer. The first elevators were inclined platforms, constructed of timber. The gravel was driven up the incline by streams of water and dropped over the end. In some instances steel elevators were later employed, the metal more readily resisting the abrasion of the boulders and sharp gravel. The method proved highly desirable when the dumpage ground was limited, and also facilitated working of ground where direct hydraulic practice was attended with some drawbacks. Within recent years it has become particularly popular in California, Oregon and other placer fields, where maximum results with a minimum of time, labor and expense, are requisite. The method has been given particular attention in Siskiyou county, California, and Josephine and one or two other counties in Oregon, and has attained its highest development in these districts.

CLASS OF ELEVATORS USED.

The elevator, as now generally used, is in the form of an inclined trough, solidly constructed of timbers, braced at points where the strain is greatest, and protected with steel plates and bands to resist the abrasion of the material. The main platform is usually eight feet wide and eighty to 100 feet in length, with the lower section composed of two layers of 1¼-inch boards. The upper portion, composing from one-third to one-half of the total length, is built of one layer of timbers. The sides vary from twelve feet wide at point of ingress to six feet at top. Each of the two sides is formed of two banks of boards, the thickness depending on the desire of the builder, although care must be exercised to form the walls sufficiently strong to resist the outward pressure of the water and gravel as it moves upward. From the elevator to the bed of gravel extends the bridge, or approach. This is generally ten feet long. The bridge and first twenty feet of the main platform are solidly constructed of heavy timber and strongly braced, as on this portion comes much of the weight and strain in operation. Steel plates one-eighth inch thick are used to protect the bridge and upper portion of incline, as the bare timber wears out rapidly under the rush and wear of the driven gravel.

At first operators were inclined to use heavy timber alone, but practice convinced the more progressive engineers that the initial cost attending the use of steel plates was amply justified, and that in the end the expense was less than when timber alone was used. In the latter instance, the time lost in replacing worn-out lumber, together with cost of labor and material, are militating factors, even in regions where excellent timber is cheap and easily obtainable. The grizzly-bars are placed at the upper portion of the elevator. These have dimensions of approximately three by six inches, protected with steel bands three inches wide and three-eighth-inch thick. The sluice boxes are placed in the elevator beneath the grizzly-bars. The riffles are situated transversely, with occasional longitudinal riffles employed to more thoroughly wash the gravel and increase the gold-saving efficiency. The riffles are formed of two by four-inch timber, covered with quarter-inch steel. The whole device is carefully placed on a solid foundation, in order to lessen vibration and avoid unnecessary strain on the somewhat unwieldly platform.

OPERATION OF "GIANTS."

Two or more giants are employed in operation. The first cuts down the gravel bank as in ordinary hydraulic mining, while the second is situated about eighty feet in front of the elevator bridge. The material washed down by the first monitor is driven behind and alongside the second, and is in turn carried upon the bridge and elevator by the auxiliary giant. The force of the hydraulic jet easily carries the mass of gravel and water up the incline and over the grizzly-bars. The fine material, containing the gold, drops through the bars into the sluice boxes in the body of elevator, while the coarse tailings are carried over the platform and dropped onto the tailings dump. Boulders up to five feet in diameter are easily carried over the incline in this manner, and by blasting the large rocks, the operator easily cleans the entire bedrock and secures a maximum gold recovery.

As the tailings pile grows in dimensions and approaches the elevator too closely, stringers, covered with a double set of boards are extended from the platform over the dump and the material ran further out. In this way an immense quantity of debris can be stacked on a limited area. When an abundance of water is available, and the property is sufficiently extensive to justify the added equipment, a third giant is often employed to drive the tailings from the dump to a barren waste ground. In this practice the third monitor drives the tailings to the dump pile as the material is dropped over the rear of the incline. While this may be advantageously employed in favorable cases, the third giant is rarely employed by small operators, as the use of timber platforms extending from the main elevator facilitates the stacking of gravel at low costs and on a satisfactory basis.

In practice it has been demonstrated that two No. 3 giants, using approximately 1200 inches of water under a 450-foot pressure, can easily handle 1200 cubic yards of gravel per day under ordinary conditions. The elevator method is successfully employed in mining gravel ranging in depth from twenty to twenty-five feet, with deposits containing numerous boulders and much difficult gravel. The mining of the ground is identical with the methods followed in hydraulicing, hence a description here is superfluous. On a property of fair extent, two or three elevators are easily operated, provided a sufficient water supply is available.

One of the objections against the elevator is the time lost in moving the machine, but under usual conditions, an elevator may be easily moved from point to point by four men and a mule, if capstan bars and other equipment are provided. As in ordinary hydraulic mining a good water supply is absolutely requisite, and the manager is necessarily forced to provide for this, before commencing the installation of equipment.

The use of the elevator has recently

spread to Alaska, South America, and other fields, and in most instances has filled a long-felt demand. The facility with which the tailings are stacked, and the compact character of the device, compared with the ordinary sluice-ways in hydraulicing, forms paramount points in its favor. The fact that elevator mining can be conducted in districts where the water resources are comparatively restricted forms another distinct factor in favor of its use. The elevator method was inspired by the attack of the anti-hydraulic forces, but its greatest development has been in districts where hostile legislation has made scant progress.

METHODS OF STACKING DEBRIS.

An effective method of stacking debris has been recently developed in some of the Alaskan and British Columbian fields, and is of considerable interest to the American placer miner, when disposition of tailings forms an important problem—as not unusually prevails. In this system two or three giants are placed at the lower section of the sluice-ways, with their streams trained to meet the tailings at right angles as they issue from the boxes. The terrific driving force of the hydraulic jets meets the gravel with full volume and drives the heavy material to the side. Gradually a pile of tailings is built up, the heap strikingly resembling the rock piles built by the stacking belt of the modern gold dredge. As the dump gathers height, the monitors are elevated gradually and a wall of gravel erected. The giants are raised or depressed as occasion warrants, until the piles attain a height of fifteen to twenty feet. The ground in front of the sluices is constantly kept clear of debris, and a restricted dumping space used most advantageously. The escaping water carries considerable fine material into the streams, but in Alaska and portions of British Columbia this is permissible, and no attempt is made to prevent the deposition of the fines in the creeks. The method described might be employed in anti-hydraulic sections, provided the water was led into restraining ponds. The great drawback against this method of stacking tailings is the large valume of water required, but in favorable districts it has proven highly effective, and is particularly popular in instances where the dumping ground is limited. The water naturally has a low duty, and considerable hydraulic equipment is required for its best employment.

The elevator method has been comprehensively tested in numerous fields and has proven its merit beyond question. It is particularly favored in districts where the water flow is comparatively limited, and is an excellent practice in disposing of tailings. Many engineers assert that it is the only machine to use in refractory ground, where water resources are restricted, and dredging is unsatisfactory. The water is conserved and a good quantity of gravel easily and fairly economically treated. In California and Oregon, costs are stated to average six to seven cents per cubic yard, with the material usually heavy and somewhat difficult to mine. When it is considered that the elevator method has been most extensively employed in a strictly hydraulic mining field, it is evident the practice must have merit. While eight to nine days are required to change and set up a machine, including the removal of giants and pipelines, the time and expense thus consumed is not infrequently balanced by the ability of the elevator to work with a small quantity of water, when a strictly hydraulic installation would be practically out of action.

THE PUMP DREDGE.

The pump-dredge claims sunny Australia as its birthplace. And to this nation and New Zealand its growth has been principally confined. Its inception and evolution was due largely to climatic coditions. Most of Australia is deficient in rainfall, and from the first the placer miners were confronted with the problem of winning the auriferous values with a minimum water supply. The dredger was early evolved in this country, but in numerous sections conditions were such that the cost of installation did not justify the building of a dredge. As necessity breeds progress, it took only a few years to develop a method for the winning of the gold from the comparatively dry placers. In Australia the pump-dredge is employed in the mining of both gold and tin, and its efficiency is demonstrated by the employment of thirty-seven machines in the province of New South Wales in 1911, while a large number were also employed in Victoria and other fields. In New South Wales ground averaging eight to nine cents per cubic yard was profitably mined, while in Victoria the material treated averaged around 12 cents.

From best figures obtainable, it appears that operating costs ranged from seven to eleven cents, depending on the natural conditions involved. The pump dredges of New South Wales treated 3,794,211 cubic yards of material in 1911, with an approximate gold and tin extraction of $830,000. The greatest field in Australia for the pump-dredge is where water is not noted for its plentitude, and where the placers are limited in extent, and the gravel somewhat difficult to dredge.

CONSTRUCTION OF PLANTS.

The pump dredge, or pump hydraulic sluicing plant, as it is sometimes designated, consists of pumps and sluices. The dredge is built on a pontoon and operates from dry land, with a flotation pond provided when possible to facilitate the moving of the equipment when conditions demand a change of operations. Should water for this purpose be deficient other means may be readily impressed to alter the position of the machine. The pontoon generally has dimensions of 40 by 50 feet, with a four-foot depth. In the case of smallest types, the platform has an average size of 30 by 40 feet. The pontoon is solidly constructed of timber, and is really a movable platform to carry the pumps. Two centrifugal pumps are mounted on the platform and wash down the gravel and elevate to the sluices. When sufficient water is available the gravel is mined by a hydraulic giant, but when this is not feasible a fourteen-inch pump generally delivers water to a four-inch monitor for gravel washing. By this method a stream of water is delivered under sufficient force to the giant to break down gravel and sluice the material to a sump situated directly in front of the dredge. The second machine, a ten to twelve-inch centrifugal gravel pump, gathers the material from the sump and elevates it to the sluice boxes. To resist the abrasion of sand and gravel, this pump is steel lined. When the gravel is very coarse, or large boulders abound, the material is screened before passing to the gravel pump. While the necessity of screening presents some objection, the cost is slight, and operations attended with little annoyance. Occasionally a particularly high lift is required, and when this occurs, the pumps are operated in series. Some of the Australian companies elevate gravel over a hundred feet by this method, and the height to which the material can be thus carried is practically unlimited. A seperate engine or motor is generally employed to drive each pump, but if desired both pumps may be operated from the same source. In the more recent designs, however, independent engines are used, resulting in the maximum application of power and ability to operate one pump should an accident to one of the engines or motors place the other out of action. By keeping an auxiliary motor or pump in reserve loss of time through accident to the active machinery is avoided. In Australian practice steam is largely employed as the motive force, but whenever possible electricity is preferred. Either mode of power may be employed and steam can, of course, be often employed in districts where electricity is

ble. The approximate indicated wer required to operate an aver- pump-dredge ranges from 120 to

LOCATION OF SLUICES.

luices are situated either above ige, or at a convenient point on k, and are provided with a set of r the conveyance of the tailings ettling pond. In many of the Aus- listricts rigid laws against depo- f tailings in navigable streams and the pump-dredge operator is y forced to respect the eixsting ons. The tailings are easily dis- to restraining ponds and all es- fine material effectively pre- The pump elevating the mater- the sump gathers the water gravel and discharges into the from which all excess water is returned to the pump supplying ing giant. In this way the same s used many times, and its duty augmented. The quantity of wa- uired is naturally regulated by cture of the ground and amount el handled, but it is estimated 00 gallons are required to each rd of material elevated. As most water is used over and over, the upply need not be large, as com- ith other methods of placer min- either is it necessary that the be particularly strong, as the upplying the giant increases the of the flow sufficiently to enable it to effectively perform the ser- manded of it. As work pro- the dredge is floated from point , or moved across the dry land e aid of men and horses, and at- equipment. A flotation pond is provided if conditions permit, this means the moving of the from one point of attack to a ation is accomplished with the ease that the bucket-elevator is stepped ahead.

eports of the Victorian Govern- cords the successful dredging of anging in depth from thirteen to ty-three feet, with many of the of a refractory character. When osit is situated in a ravine or the material may be easily ele- o the sluices situated on higher employing additional pumps. Ac- y, the pump-dredge is extensively d in the mining of deposits that ardly be otherwise worked. While ts attending the construction of dredge varies with local condi- e average building epense ranges 15,000 to $30,000, depending on ons of the installation. Taking ors in consideration, and apply- eneral rule to calculations, the Australian engineer reckons on $20,000 to $28,000 for a dredge of ordinary power and size. Compared with the high cost of the bucket-elevator dredge, the expense attending construction of a pump-dredge is insignificent.

ORIGIN OF PUMP-DREDGE.

The idea of the pump-dredge properly originated from the employment of gravel pumps on the old-style double-lift bucket-elevator dredges. In this practice the gravel was dumped by the dredge buckets into a watertight compartment on the boat. Centrifugal pumps then gathered up the material and elevated to the sluices extending behind the dredge. The Australian pump-dredge is the application of the hydraulic principle for the mining of the ground, and of pumps for the raising of the material to the sluices. In other words, the monitor and pumps perform the work of the bucket line and stacking conveyor on the elevator dredge. The elevator dredge performs the work more rapidly and economically, but the pump-dredge operates in districts where the employment of the modern gold elevator boat is practically precluded. The elevator dredge is a costly affair, and the ground must be sufficiently extensive to justify its installation. No dredge mining engineer would think of installing a dredge in a district where the area was so limited that the eventual result would mean loss to the company. The place of such boats are in large fields where a fairly lengthy period of operation is assured. And it is in the mining of the small deposits that the pump-dredge has proven particularly efficient. The pumps clean the bedrock more effectively than any other method, and practically every speck of gold is recovered from the channel in this way. Even the most uneven bedrock is forced to yield up its finest particles of gold.

The great field for the pump-dredge is where the district contains small deposits, particularly when scarcity of water and rough bedrock militates against hydraulic mining or other methods of placer activity. In usual hydraulic practice a constantly fresh supply of water under strong pressure is requisite, and a convenient dumping ground, lower than the worked deposit, is preferable. In dump-dredging the same water is used many times and the pumps readily elevate the product to dumping ponds located far above the placers. In this way a small supply of water may be effectively applied, and the tailings distributed to best advantage in a restricted dumpage area.

Another point in which the pump-dredge excels is its ability to operate in districts where hostile legislation prohibits hydraulic mining under ordinary methods. The tailings are easily run to the settling ponds and the withdrawal of excess water from the restraining dams prevents the escape of the fine material to the streams draining the territory. This factor in itself is worthy of emphatic attention. In California and other fields where anti-hydraulic laws have closed placer properties of unquestioned merit, the disposition of the tailings forms the paramount factor. Efforts have been made to operate by constructing costly restraining barriers to hold the debris in leash, but rarely without completely satisfactory results. In Australia the pump-dredge is said to have solved this important problem most effectively. As most of the water is returned to the pumps from the tailings ponds, the fine material settles and is less easily dislodged, even by the fiercest of winter storms.

WHERE PUMP-DREDGE SHINES.

The pump-dredge was never intended to take the place of the bucket-elevator dredge. It can not compare with the latter in point of efficiency, low operating costs, or capacity. It finds its greatest application in districts where conditions are inimical to the elevator dredge, where restricted deposits, unfavorable ground and other circumstances do not warrant the installation of the larger and more costly boats. It has proven particularly efficient where it has been necessary to elevate the gravel to obtain a sluicing grade. It is intended to do for the small, isolated deposit what the bucket machine accomplishes in the district of vast gravel channels and fairly good workable ground. The high operating costs, compared with that of the bucket dredge, necessitates that the deposit contain a fairly high gold content, otherwise an installation could not but result in failure. The engineer must be conversant with extent and structure of the deposit before recommending an installation, whether the machine be a pump-dredge, hydraulic plant or elevator dredge. All pump-dredges have not been successful, but when conditions have been favorable the percentage of failures are reported to have been exceedingly small.

Thus far the pump-dredge has been given scant attention by the American placer miner, although there are numerous districts in the western states where it could undoubtedly be profitably installed and operated.

A comparison of the elevator and pump-dredge methods of placer mining is necessarily dependent on strictly local conditions. There are districts where each method is peculiarly available and advantageous, and the writer is unaware of a single instance in which the two machines have been placed in direct competition under identical circumstances.

Both methods facilitate the working of small deposits with a minimum water supply, and tailings are effectively handled in either instance. Screening is unnecessary in elevator mining, but the centrifugal pumps clean the rough bedrock far more effectively than ever the elevator operator dreamed of. It seems that in many districts the two machines might be combined effectively into a complete plant, but in most instances this would probably be unnecessary, as either contrivance performs its work well.

The elevator method is well understood by the American placer operator, but the pump-dredge has been hitherto neglected, although its merit has been conclusively demonstrated by the operators of a foreign region, where natural conditions not infrequently resemble those confronting the miner in many placer fields of America.

In Australia labor forms the most costly item on the expense sheet, often ranging six to eight cents per cubic yard. By operating a number of machines, this cost would naturally be reduced by a strong company, directed by intelligent management. Power costs command consideration, but in many American districts electricity is available at fair rates, and this would probably result in operations at costs below the scale prevalent in most Australian districts. In any event the pump-dredge is entitled to more consideration than has been accorded it by American operators.

Production of Copper in 1912

Statistics and estimates received by the United States Geological Survey from all plants known to produce blister copper from domestic ores and from all Lake mines indicate that the copper output of the United States in 1912 exceeds that of any previous year in the history of the industry. Not only is the total output the largest ever recorded, but six of the large copper-producing states—Arizona, Michigan, Utah, Nevada, New Mexico and Alaska—have each exceeded all former records of production, while Montana and Tennessee have nearly equaled their previous record productions.

SMELTER PRODUCTION.

The figures showing smelter production from domestic ores, which have been collected by B. S. Butler, of the Geological Survey, represent the actual production of most of the companies for eleven months and an estimate of the December output. The November figures for a few companies were not available and these companies furnished estimates for the last two months of the year. According to the statistics and estimates received, the output of blister and Lake copper was 1,249,000,000 pounds in 1912, against 1,097,232,749 pounds in 1911.

At an average price of about 16 cents a pound the 1912 output has a value of nearly $200,000,000, against $137 154,092 for the 1911 output.

REFINED COPPER.

Preliminary statistics showing the output of refined copper are not collected by the Geological Survey. Figures published by the Copper Producers' Association show an output of 1,429,147,150 pounds for the first eleven months of 1912 and indicate that the production of marketable copper by the regular refining plants from all sources, domestic and foreign, will amount to about 1,560,000,000 pounds for 1912, against 1,433,875,026 pounds in 1911.

IMPORTS AND EXPORTS.

According to the Bureau of Statistics imports of pigs, bars, ingots, plates, and old copper for the first eleven months amounted to 276,508,505 pounds, and the copper content of ore, matte, and regulus imported amounted to 94,486,041 pounds. If the imports for December were equal to the average monthly imports for the first eleven months the amount of copper entering the United States for the year was about 404,721,323 pounds, against 334,607,538 pounds for 1911. Considerable of the copper imported as blister had been previously exported as ore.

Estimates based on figures for the first eleven months published by the Bureau of Statistics and also by the Copper Producers' Association indicate that the exports of copper for 1912 will not equal those of 1911 but may exceed 750,000,000 pounds.

Stocks of refined copper held in the United States January 1, 1913, are probably about the same as on January 1, 1912. Foreign stocks show a considerable decrease.

DOMESTIC CONSUMPTION—PRICES.

Statistics published by the Copper Producers' Association show the domestic deliveries for the first eleven months of the year as 761,174,225 pounds and indicate a marked increase in domestic consumption, which will probably reach 825,000,000 pounds for the year and may exceed that amount.

The average quoted price of electrolytic copper for the year showed a marked increase over that for 1911. The average for 1912 was about 16 cents a pound, as compared with 12.5 cents a pound for 1911. The year opened with copper at about 14 cents a pound, but since June the monthly average has not been below 17 cents.

COPPER-PRODUCING STATES.

Arizona—For 1912 Arizona again holds first place among the copper-producing states. The output will show a large increase over the 303,202,000 pounds produced in 1911 and may exceed 350,000,000 pounds. This is not only the largest output ever made by the state but the largest ever made by any state for one year.

The production of copper from the Bisbee district will show a large increase over the 130,200,000 pounds in 1911 and may exceed 145,000,000 pounds for 1912. A new smelting plant was under construction by the Calumet & Arizona Co. during the year.

The output of the Morenci-Metcalf district will show a considerable increase over that of 71,500 000 pounds for 1911 and may reach 80,000,000 pounds for 1912. The building of a new smelting plant by the Arizona Copper Company was in progress during the year.

The Globe-Miami district will show a large increase over the production of 44,600,000 pounds in 1911, this being due to the larger output by the Miami Copper Company. The production for 1912 may reach 55,000,000 pounds. The larger producers were the Old Dominion, United Globe, and Miami companies. During the year the Inspiration Consolidated Copper Company was formed by a merger of the Inspiration Copper Company and the Live Oak Copper Company. Development and blocking out of ore was carried on by this company and plans for a concentrating plant set under way. Development was carried on by other companies.

In the Jerome district the output of the United Verde mine will show little change from the 33,200,000 pounds produced in 1911.

The production of the Mineral Creek or Ray district will show a large increase over 1911, owing to the larger output of the Ray Consolidated Company, the only large producer of the district. The output for the year will be between 30,000,000 and 35,000,000 pounds.

In 1912 the Ray Consolidated Company secured controlling interest in the Ray Central Company and the properties will be worked together. The smelting plant of the American Smelting & Refining Company at Hayden was placed in operation during the year.

Montana—The copper output of Montana will show a large increase over the 271 814,491 pounds produced in 1911, owing to the stimulation to production

given by the increase in the price of copper. The 1912 output may reach 310,000,000 pounds. The Butte district, as in previous years, was the only large producer. Montana ranked second in copper production in 1912.

Important additions to the ore reserves of the Butte district are reported and improvements have been made in the methods of extracting and treating the ores with a view to decreasing the cost of production.

Michigan—The production of copper from Michigan, which ranks third among the copper-producing states, will show an increase of nearly 15,000,000 pounds over the output of 218,185,235 pounds in 1911. The output was made largely by the old producers and the increase was due to the stimulation of higher metal prices. Development of new territory has been active during the year.

Utah—The production of copper in Utah in 1912 will show a considerable increase over the 142,340,215 pounds produced in 1911, the increase being due to the increased output of the Bingham district. As in previous years, the Bingham camp was the main producer, though the Tintic district had a considerable production and the San Francisco and other districts also contributed. The output of the mines at Bingham was stopped for a time in the latter part of the year by labor troubles, thus materially reducing the ore production of the state.

Nevada—The copper production of Nevada in 1912 will show a large increase over the 65,561,015 pounds produced in 1911. The increase is due largely to the beginning of noteworthy production from the Yerington district. The total state output for 1912 will probably reach 80,000,000 pounds. The Ely and Yerington districts were the only large producers. In the Yerington district the smelter of the Mason Valey Mines Company was blown in early in the year and operated thereafter. The output of the district will probably reach nearly 15,000,000 pounds. The Ely district will show a slight increase over the 64,900,000 pounds produced in 1911, though production was interfered with by labor troubles in the latter part of the year.

California—The production of copper in California in 1912 will probably show little change from the 35,835,000 pounds produced in 1911. As in previous years the Shasta county district was the largest producer, but notable contributions were made also by the Foothills district and other districts of the state.

New Mexico—The output of copper from New Mexico in 1912 will show a large increase over that of 1911, owing to the beginning of noteworthy production by the Chino Copper Company, of the Santa Rita district. The total production of the state will reach nearly 30,000,000 pounds, the large part coming from the Santa Rita district.

Alaska—Alaska will show a large increase in the production of copper in 1912 over the 22,314,000 pounds produced in 1911, the total having been estimated as 28,940,000 pounds. The output came largely from the Copper River and Prince William Sound districts, though southeastern Alaska also contributed.

Tennessee—Tennessee will show but little change in copper production in 1912 from the 18,965,000 pounds produced in 1911. The output, as in previous years, came from the Ducktown district.

Colorado—The output of copper from Colorado is largely incidental to the production of other metals and will probably show no great change in 1912 from the 9,791,000 pounds produced in 1911.

Idaho—Idaho will show a considerable increase in copper output in 1912 over the 4,514,116 pounds produced in 1911.

There will be no new large producing mines added during 1913. Several of those that began producing in 1911 and 1912 will, however, turn out larger quantities than in 1912. At the prices for copper prevailing during the latter part of 1912 the industry is highly profitable, and if the output can be marketed and the price maintained the producers will be in a position to make a still further large increase in 1913.

PIKES PEAK NOT THE HIGHEST.

What is the higest mountain in Colorado? "Pikes Peak," nineteen persons out of twenty will answer, and incorrectly. The twentieth may know that the two highest mountains in the state are Mount Massive and Mount Elbert, both in Lake county, in the Leadville district. The altitude of each of these mountains, according to the United States Geological Survey, is 14,402 feet above sea level. The height of Pikes Peak is 14,108 feet. Moreover, there are fifty or sixty other peaks in Colorado approximately as high—over 14,000 feet. The lowest point in Colorado is 3,350 feet above sea level. Of all the states Colorado has the highest average altitude, estimated by the Geological Survey at 6,800 feet.

Although not the highest mountain, Pikes Peak is probably the best-known peak in the United States. There was at one time a Weather Bureau station on its summit, and it now has a substantial railway station at the terminus of the highest railway line in North America. It can also be reached by an excellent wagon road and trail which connect the summit with Colorado Springs.

NO FREE ASSAYS MADE

Attention is called by the United States Geological Survey at Washington to the fact that it does not make analyses or assays of ores or metals for private parties. Many specimens and samples are received by the Survey, accompanied by requests for such treatment, with which it is impossible to comply. The force of chemists employed in the Survey is small, and their time is fully occupied by their regular official duties. The Geological Survey has no facilities at all for making gold and silver assays. The most that can be done is for the Survey geologist to give an off-hand opinion based on a simple examination of the specimen. If an assay is desired, the proper course is to employ a private assayer or to send the specimen to one of the government assay offices, where a regular charge is made for such work. When specimens are sent to the Survey for examination, applicants should be particular to state whether they wish them returned, as otherwise they will be destroyed. Government assay offices are located at Carson, Nev.; Seattle, Wash.; Boise, Idaho; Helena, Mont.; Salt Lake City, Utah, and Charlotte, N. C.

E. & M. JOURNAL'S NEW DRESS

The Engineering and Mining Journal is out in a "new dress"—that is, it has changed the style of its make-up from three to two columns to the page and is using a new and larger-faced type. One of the charming features of the Journal, always, has been its scrupulous attention to "dress" (mechanical appearance) and, while there are most likely compensating features in the latest change, it will take readers some time to convince themselves that the "new suit" can be compared with the old. The face of the body type is not nearly as pretty and it lacks in classy individuality. The longer lines will unquestionably result in better spacing between and division of words, and these are features that will appeal to writers, proof-readers and patrons, as well. But the Journal, in its old dress, was a handsome reflection of the art of printing and the change comes rather as a shock than a refreshing surprise. However, tastes differ materially, and possibly no one else will view the change as we do. The Journal is, without question, the best of its class in the world, and whether it appears in "homespun" or "broadcloth" will make little difference to the thousands who consult its pages with religious regularity.

From Copper To "Gold Mines"

This space is reserved for the picture of A. F. Holden, the other eminent engineer who lent his name and gave his endorsement to the electrifying report on Alaska properties submitted herewith and which will be reproduced from month to month.

NOTED ENGINEERS JOIN BROKERAGE HOUSE IN A REMARKABLY PECULIAR PRESENTATION OF AN ALASKA GOLD MIRAGE.

We have considered the PROBABLE capital requirements for a capacity of 6,000 tons per day, which contemplates a hydro-electric power plant; mine development and equipment, including all the necessary living quarters, both at the Perseverance mine proper and at the mill, and driving the long adit tunnel. We BELIEVE that $4,500,000 will do this owrk.

Our belief is that the substantially INDICATED ore body is about 4,500 feet long by seventy feet wide. The value of the 600,000 tons of ore THAT HAVE BEEN MINED FROM THIS BODY IN THREE DIFFERENT LARGE STOPES INDICATES that a recovery of at least $1.50 per ton can be made. We BELIEVE that there will be 75 cents per ton profit in this grade of ore. The Sheep Creek Tunnel which will be driven on the vein as the main haulage level, will develop this ore body at an average depth of about 2,200 feet on the dip of the vein or about 700 feet deeper than present developments.

The character of this vein is similar in A VERY GENERAL WAY to other large deposits of gold ore in the same vicinity in which the values at a vertical depth of 1,600 feet, or 2,000 feet on the dip of the vein from its apex, are practically the same today as they were on the surface, and have been throughout the development of THE DEPOSITS IN QUESTION. We visited these mines and saw THEIR deep levels, and if there is any inference to be drawn from the continuity of THESE ore bodies, WHICH ARE NOT, HOWEVER, ON THE SAME VEIN AS THE PERSEVERANCE, one MIGHT BE TEMPTED to say that there is a PROBABILITY of ore 2500 feet deeper than the so-called Sheep Creek Tunnel which we contemplate driving, BUT, while the PROBABILITY is there of the vein and values extending to great depth, THERE IS NOTHING TODAY TO WARRANT ANYBODY IN STATING THAT IT IS A FACT THAT SUCH WILL BE THE CASE.

There are substantially 50,000,000 tons in the ore body we consider definitely INDICATED. There is a PROBABILITY of another 2,000 feet to the east of the 4,500-foot ore zone previously mentioned which, from surface indications, would seem FAIRLY CERTAIN to contain ore. Beyond this is some 1,800 feet of the vein concerning which we have NO FINAL OPINION one way or the other, AS WE VISITED NO WORKINGS OR OUTCROPS from which we could secure sufficient data to form accurate deductions. While we cannot at this time state that there IS ore here, there were several SMALL MINES worked almost at the extreme east end of the vein on this property, which INDICATES that this 1,800 feet will undoubtedly produce considerable ore and PERHAPS LARGE QUANTITIES. If we do not consider this in the PROBABILITIES, it is certainly well within the POSSIBILITIES.

This letter is based solely on a consideration of $1.50 recoverable value as ore. If one should figure on lower values assuming 75 cents as the total cost of mining and milling, the tonnage now indicated is INDEFINITE, but certainly enormous. We BELIEVE that sound mining business will INDICATE that for the installation now proposed and for an operating period of, say, two years, IT WILL BE WISE TO CONFINE OUR WORK TO THE HIGHER GRADE ORE. There can be, in our opinion, little doubt that at some time in the comparatively near future A VERY MUCH LARGER PLANT than the one now proposed will be installed for the purpose of working a larger tonnage of the normal grade ore we now EXPECT will be developed, or of utilizing the apparently vast quantity of lower grade material.

The INDICATED earnings from the installation now contemplated are approximately $1,500 000 per annum. Considering the TREMENDOUS POSSIBILITIES, and we use the word "tremendous" advisedly, we BELIEVE this mine to be a LEGITIMATE purchase at $15,000,000 and A BARGAIN at $12,000,000, provided that, in both cases, a development, equipment and working fund of $4,500,000 is made available. You must understand and appreciate that we do not consider the 6,000-ton per day development and installation as the ultimate possibility of the mine or anywhere near it. The POSSIBLE tonnages of ore INDICATED in this property APPEAR to be greater than any vein deposit WE know about.

We EXPECT the first unit of the new mill to be in operation on or before January 1st, 1915. We really BELIEVE that, barring accidents, the time MAY be made July 1st, 1914.

(Signed, July, 1912.) D. C. JACKLING.
A. F. HOLDEN.

Already the management of this herculean undertaking is preparing to increase the stock and issue bonds under the bold assumption that the 50,000,000 tons of ore now "believed" to exist will be increased to 200,000,000 tons within a short time. This showing, an article in the Evening Telegram of recent date, says, will require making the proposed 6000-ton mill a 20,000-ton affair. Thus, before it is known whether the ore can be treated at any profit—really before it is known whether the ore will average even 25 cents a ton in recoverable value, the company's proposed new financing scheme is being exploited. First they tell you they "believe" $4,500,000 will be ample for all purposes of development and equipment. Then, almost before the ink is dry on that published statement, they begin paving the way for bleeding the public proper. The next stock will be put out at $20 or $25 a share, they promise.

MIAMI COPPER COMPANY'S MINING AND MILLING ENTERPRISE

By JAMES O. CLIFFORD.*

The mines and mill of the Miami Copper Company are at Miami, Gila county, Arizona, about eight miles northwest from Globe. Miami is at the extreme western terminus of the Gila Valley Globe & Northern railway, a branch line of the Southern Pacific railway, connecting with the main line at Bowie, 134 miles southeast of Miami.

The company controls about 1250 acres of land in the Miami district, of which 300 acres are mineral, the remainder being held for mill purposes, and water right. Other mining properties immediately adjoining the Miami Copper company are: Inspiration, Keystone, Live Oak, and South Live Oak, and all of which are opened upon the same orebody. At present the Miami Copper Company is the only producer of the district, though preparations are now under way for the construction of a 7500-ton mill on the Inspiration property.

As outlined in a previous paper (Mines and Methods, December, 1912), the Miami district, geologically, has many features in common with the Ray district, the latter twenty miles southwest. Here, as at Ray, the workable ore of the disseminated copper deposit practically is confined to the altered schist, though intrusive tongues of granite-prophyry in the schist also are ore-bearing.

Generally speaking, the Miami district is an exact counterpart of the Ray district, the rock series of the ore-bearing area consisting principally of a granitic basement overlaid by altered schist, through which diabase has been intruded. Remnants of an extensive dacite flow which formerly covered the schist is apparent, both as capping on the surrounding hills, and as huge boulders (in many instances heavily mineralized) along the faults of the Miami mine. A large mass of conglomerate occurs immediately to the east of the Miami shaft No. 2. Limestones, shales, and quartizites are not present, only to the east and the south of the Miami orebody.

The structural relations of the Miami rock series are practically the same as those at Ray. Reverse faulting occurs at many points throughout the developed area. Also, in many instances, what are really "lines of erosion" are often mistaken for fault planes.

The principal ore deposits at Miami consist of an unusually fine dissemination of chalcocite throughout a mass of altered schist, with accompanying veins of solid glance—the latter generally along lines of greatest fracturing, and adjacent to the porphyry. Chrysocolla occurs in unusual development in the extreme western limit of the district. Pyrite and chalcopyrite occur locally in the upper horizon.

CHARACTER AND EXTENT OF ORE-BODY.

The Miami orebody occurs in the form of an inverted top, averaging, as at present developed, 500 feet thick, and covered by 100 to 300 feet of capping. The continuity of the ore, which is almost a solid body, makes it readily amenable to mining by a modified caving system. According to official reports there is fully developed approximately 19,000,000 tons of ore having an average copper content of 2.58 per cent. In addition there is partly developed a considerable tonnage below the 700-foot level which has not yet been made public, and is said to have a higher general average copper content than the orebody above. In fact, developments indicate a substantial increase in developed ore reserves, but the Miami management prefers to calculate its ore tonnage only when it has actually been blocked out. Consequently, it is unlikely that any definite figure will be obtainable for some time. Further, it is generally understood that lenses of high-grade copper ore have been encountered by the two diamond drills operating from the lower mine levels.

As at Ray, the disseminated ore deposits of Miami owe their origin to the intrusive diabase, and are in the nature of a contact phenomenon similar in general to other well known "porphyries," though substantially different in point of specific relation.

The intrusive diabase is responsible for the highly-mineralized area of the district limiting the "disseminated" zone, and considers (1), the primary mineralization of the zone represented by the altered schist, and (2), a probable secondary mineralization at a lower horizon. The inter-zonal region is represented by the presently determined disseminated copper ore-deposit in schist, immediately underlaying the oxidized capping.

Miami Concentrator—Pond in Which Reflection is Seen is Now Filled With Tailing.

The primary mineralization did not form workable orebodies, except locally in small veins. The workable disseminated deposits are due to secondary enrichment occasioned by the degradation

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of the lean ore near the surface, and subsequent transportation of the copper salts therefrom to a lower horizon, replacing the pyrite of the unoxidized zone by chalcocite. Progressive lowering of the surface by erosion, with attendant oxidization, has brought about constantly recurring concentration of the copper minerals, leaving the earlier formed chalcopyrite, or chalcocite, to be oxidized and its copper content carried downward to form new glance. The secondary mineralization is confined to the unaltered intrusive diabase, probably in part represented by concentrations of copper minerals at intermediate points making workable bodies of high-grade copper ore.

The granite seems to have served only in bringing about a silicification of the schist, the result of contact metamorphism. The later mineralization, resulting from the decomposition of the lean ore near the surface, enriched in part, the included tongues of granite as well as the schist.

Pyrite and chalcopyrite are the primary minerals impregnating the altered, silicified schist; chalcocite is due to intensive secondary enrichment forming the commercial orebodies mentioned in a preceding paragraph; the oxidized copper ores occurring in parts of the Miami mines were formed in situ by decomposition of the sulphides, and therefore it is to be expected that such bodies overlay deposits of sulphide ore. The chrysocolla affords a peculiar relation to the principal disseminated deposits of the district, occurring principally to the extreme western area in the Keystone and Live Oak mines, which have been extensively developed and extracted. Strangely, the area wherein these deposits occur is confined to the region of the greatest block faulting, and evidences a probable deposition from post-dacitic mineralization, although there seems to be no absolute line of facts countenancing the theory. To the contrary, there seems to be no positive proof of sulphide mineralization later than the dacite.

MINING AND DEVELOPMENT.

The Miami company in developing its orebody did not rely upon the modern plan of determining the extent and value thereof by churn-drilling, but preferred to block out the ore in the old-fashioned manner—by means of shafts, drifts, raises, and so forth. Consequently, in lieu of carefully compiled statistics outlining the "actual" ore tonnage estimated from drill-hole records, the Miami orebody was carefully developed and the ore actually "blocked out" in such manner that the estimates of tonnage, and average copper content, were as correct as mining practice could make them. Aside from this marked advantage the actual development has greatly anticipated the mining requirements, and while it appears extravagant to expend too much capital in developing the mine in advance of mill requirements, as the Miami management has done, it suggests unusual foresight when compared to the practice indulged by some companies in calculating tonnages of ore which exist only in stock-market reports and the minds of the management. Similarly, the management of the Miami Copper Company, in the process of delimiting new orebodies is not desirous of making note thereof till it is prepared to offer correct figures derived from actual development of added ore reserves.

The extraction of the Miami orebody has been begun in the upper area, immediately underlying the oxidized capping. The method of mining employed in this area is by square-setting and slicing; the principal object sought is the extraction of the ore immediately underlying the capping which must be mined now, if ever. No pillars of ore are left in the area mentioned, the plan of forming a thick mat of timber between the capping and the ore keeping them separate when the caving is in complete operation, and incidentally affording a high percentage of ore extraction, with a minimum admixture of waste. This system of mining in the upper stopes occasions a relatively high expense for timber, amounting to about 20 per cent of the total cost of mining, which latter ranges from $1.10 to $1.30 per ton of ore extracted.

The Miami orebody is developed by four shafts, commonly termed Nos. 1, 2, 3 and 4, respectively. Shaft No. 2 is sunk into the supposed center of the orebody; shaft No. 4 is about one-fourth mile eastward from shaft No. 2 and was sunk in the mass of conglomerate forming the ridge upon which the mill was constructed. Shafts Nos 1 and 3, are merely development shafts in comparatively new areas. Shafts Nos. 2 and 4 are over 700-feet in depth; the former being used principally as a development shaft serving the lowest levels of the mine, and as supply entry, the latter being the main hoisting shaft of three compartments through which all ore for the mill is drawn, and as a manway. Individual steam power plants are used at all shafts. Main shaft, No. 4, is equipped with two Nordberg steam hoists; one, a double-drum hoist operating 7½-ton skips in balance serving as the main ore hoist for the mill; the other, a smaller Nordberg steam hoist serving the third, or manway, compartment of the shaft.

The first mine-level is driven in ore at 220-feet below the surface. The main haulage levels are at 420-ft. and 570-ft., respectively, and intervening levels are 50-ft. apart. Later a level will be opened at 720-ft. All levels between shafts Nos. 2 and 4 are connected, and connections will later be made between those shafts and Nos. 1 and 2. The mine is blocked out in 50x50-ft. sections, each block having two chute raises on each side for transferring ore from the upper levels to the main working levels. All of the ore is taken from the three upper level sections of each block, 25x25-ft. being blasted into the chutes, in which manner the ore in the upper levels can be extracted without permanent timbering. The same plan will obtain with reference to the lower levels, although no ore will be extracted from the lower levels until the area above the 420-ft. level has been mined. The haulage levels at 420-ft. and 570-ft., respectively, are electrified, the ore being handled in electrically-driven ore-trains of six cars each to the main hoisting shaft, No. 4, where it is automatically dumped by placing the ore cars in tipples, the ore dropping into an ore-pocket, 30x50-ft. dimensions, by the side of the shaft from which the ore passes through chutes controlled by air operated gates into the 7½-ton skips, whence it is hoisted to the surface and automatically dumped into the ore-receiving bins near the head-frame, and immediately above the coarse-crushing plant.

Throughout, the management nas done highly creditable work, and every effort is put forth to protect miners and other employees working underground by ample timbering. Further, Americans are given preference in the matter of employment over foreigners. Altogether there is no evident indication of attempting to sacrifice either human lives by faulty methods, or the efficiency of the employees by creating a race prejudice. The result has been eminently satisfactory to all concerned, and, there is not, among the many companies engaged in the mining of large deposits of disseminated copper ores, one that has succeeded in improving the morale of its skilled labor to the same degree that has the Miami Copper Company.

THE MIAMI CONCENTRATOR.

The company's concentrator is situated on the ridge immediately south of and adjoining the No. 4 shaft head-frame. In point of structural excellence, and mechani-metallurgical efficiency, it has no superior among the many types of mills treating the low-grade disseminated copper ores. The mill is unusually spacious; perfect interior lightning is afforded, both by day and night; the launder, shafting, and belting plan is excellent; and of particular interest is the fact that the premises are scrupulously clean. One may go through the Miami

mill without fear of either physical injury, or soiling one's best clothes. Further, the mill is arranged so that, should it be necessary, at any time, to effect changes in the machinery (either through permanent change in the qualities of the ore, or improvements in the art of ore-dressing), it will be an easy matter. The additional cost of construction of the mill is more than off-set by the marked advantages afforded in every respect, and, in fact, the cost has not been excessive when this mill is compared to others of inferior construction.

Power Plant.—The central power plant is located on the flat below the concentrator, where it may be reached by the railroad. The building is constructed of steel and reinforced concrete, 75x265-ft. dimensions.

The steam-plant consists of three batteries (two water-tube boilers of 600-h.p. each, forming a battery) of boilers, all oil-fired. Feedwater and oil is supplied by compound Fairbanks-Morse pumps. A complete system of economizers is installed to care for the waste-heat from the boilers, thereby reducing the fuel expense to a low figure.

Power is generated by three four-cylinder, triple-expansion, Nordberg-Corliss engines, having high-pressure cylinder of 19-in., intermediate cylinder 37-in., and two low-pressure cylinders of 40-in., all having a common stroke of 48-in. Crocker-Wheeler, 25-cycle, 1200 K.V.A., 6600-volt generators are direct connected to the driving shafts of the Nordberg engines. Steam is delivered to the engines at 185-lb. boiler pressure, and 100-deg. superheat. The engines operate at 107 revolutions per minute. Electric power from this central plant is transmitted to sub-stations at 6600-volts, and transformed to 500-volts for use in the mines and mill.

Two four-cylinder, triple-expansion, Nordberg air compressors, with a rated capacity of 4000 cu. ft. of air per minute at 90-lb. pressure when the engines are operating at 100 revolutions per minute, supply the necessary compressed air for underground mining machinery. Two four-cylinder, triple-expansion, Nordberg condensing engines care for the water circulating system. Two 100-k.w. Nordberg exciting engines care for the larger electric generators.

Water Supply.—Water is obtained from the Old Dominion Copper Company, at Globe, about seven and one-half miles southeast from Miami. The water from the Old Dominion flows to Burch station, about midway between Globe and Miami on Pinal creek, and about 175-ft. lower than the mill. The Burch pumping station is equipped with two Nordberg electric pumps. Each of these pumps is capable of delivering 1600-gals. of water per minute when operating at 150-revolutions per minute. The pumps are electric-driven by 400-h p. motors using current direct from the transmission line at 6600-volts. Additional water is supplied from numerous bored wells, operated by compressed air, the power being supplied by Ingersoll-Rand air compressors. The Old Dominion supplies about 2,000,000 gallons daily, and the driven wells furnish a variable quantity of from 300,000 to 500,000 gallons per diem. An elaborate tailing dewatering plant, described in a later paragraph, effectually recovers about 85 per cent of the mill water used, thereby considerably reducing the water supply expense. The expense for water at present amounts to about 5 cents per ton of ore treated in the concentrator.

Mill.—The ore hoisted through main shaft No. 4 is dumped, automatically, from the skips into steel ore-bins immediately adjoining the headframe. From these ore-bins the ore is passed over grizzlies having 2-in. spacing, the undersize going directly through two sets of 24x52-in. spring rolls, reducing to ¾-in., and the oversize passing through two No. 7½ Kennedy gyratory crushers, being reduced to pass a 2-in. ring. The crushed material from the Kennedy crushers goes through a 4x12-ft. revolving trommel having ¾-in. perforations, the oversize from which passes through the 24x52-in. rolls. All material handled in the coarse crushing department is reduced to pass ¾-in. ring, and then is delivered to a 30-in. by 279-ft. inclined belt conveyor which elevates the crushed ore to a point above the concentrator fine-ore storage bins where it discharges upon a horizontal belt-conveyor 30-in by 329-ft., the latter distributing the fine-ore to the six cylindrical steel ore-bins, each of 1,000 tons capacity. The horizontal belt-conveyor serving the mill storage bins is equipped with an automatic tripper, traveling back and forth on a track along the conveyor line.

The main shaft, No. 4, the crusher building, and fine-ore storage bins all are situated on a ridge above the power plant. In line with the bins, and upon the side of the hill, is the concentrating plant. Under this arrangement the ore, during the concentration, is constantly being carried downward by gravity, thus passing through the process with no further necessity for mechanical handling.

Each fine-ore storage bin is equipped with an automatic disc feeder and ore sampler, which regulates the feed to the 14-in. by 24-ft. belt-conveyor serving a set of 16x42-in. spring rolls, or, in one or two sections, Burch rigid rolls. The automatic disc ore-feeder and sampler is arranged so that every fifth revolution of the disc a portion of the ore is diverted as a sample. By this arrangement an analysis of the ore may be made at the time the ore is delivered for treatment, and the nature of the treatment required determined.

Throughout the plant, that is, where the necessity exists, installation of modern automatic machinery is made. Powerful electro-magnets have been placed along the line of the belt-conveyors to the mill storage bins, for the purpose of eliminating scraps of iron and steel intermixed with the mine-run ore, which, if not removed would seriously damage the crushing machinery. Also, weightometers have been installed both on the large belt-conveyors serving the fine-ore bins, and similarly, on the conveyors serving the fine-crushing department of the mill. This latter arrangement is very advantageous, as it insures a means of carefully checking the ore tonnage handled.

Details of Operation.—The following outline briefly describes one section of the concentrator, all others, (except as noted hereinafter regarding changes yet to be made) being duplicates thereof:

From the belt conveyor serving the fine-ore bins, the material is delivered to 16x42-in. rolls set to reduce the ore to one-eighth inch. Some of the mill sections are equipped with Burch rigid rolls, others with spring rolls. The crushed material from the rolls is dropped onto two 24x48-in. traveling belt screens of 16-mesh, the undersize from which goes direct to two 10-spigot Richards pulsator classifiers, the oversize passing through three 8-ft. Hardinge pebble mills (in two sections of the mill through 6-ft. Chilian mills) reducing to pass 12-mesh. From the Hardinge mills (or Chilian mills) the pulp is distributed to the two 10-spigot Richards classifiers. The overflow from the classifiers goes to two 12-ft. conical settling tanks, and each of the ten classifier spigots serves a different group of Deister sand tables. The three first spigots each serve individual Type A. Deister Simplex sand tables; the remaining seven spigots each serving individual Type 2, special size, Deister sand tables. The sand tables make a clean concentrate which goes directly to the concentrate storage bins for dewatering.

Formerly the first three sand tables made no middling, the tailing therefrom going to a 6-ft. Hardinge pebble mill in the No. 1 tunnel (directly underneath the sand table floor), being reground to pass 14-mesh, thence treated on two Type 2, special size, Deister sand tables, the latter producing a clean concentrate which was delivered to the concentrate storage bins, and the tailing passing into the race. Also, the tailing from the remaining seven Deister sand tables was sent to the first four Deister slime tables on the second floor of the mill, now represented by the treatment of the over-

flow from the two 12-ft. settling tanks in sixteen 6-ft. settling tanks serving sixteen individual Deister slime tables, the first four of which were then reserved for the treatment of the combined tailing from the sand tables, and the thickened pulp from the first four 6-ft. settling tanks. Later the flow-sheet was revised as shown in the accompanying abbreviated flow-sheet diagram of one unit.

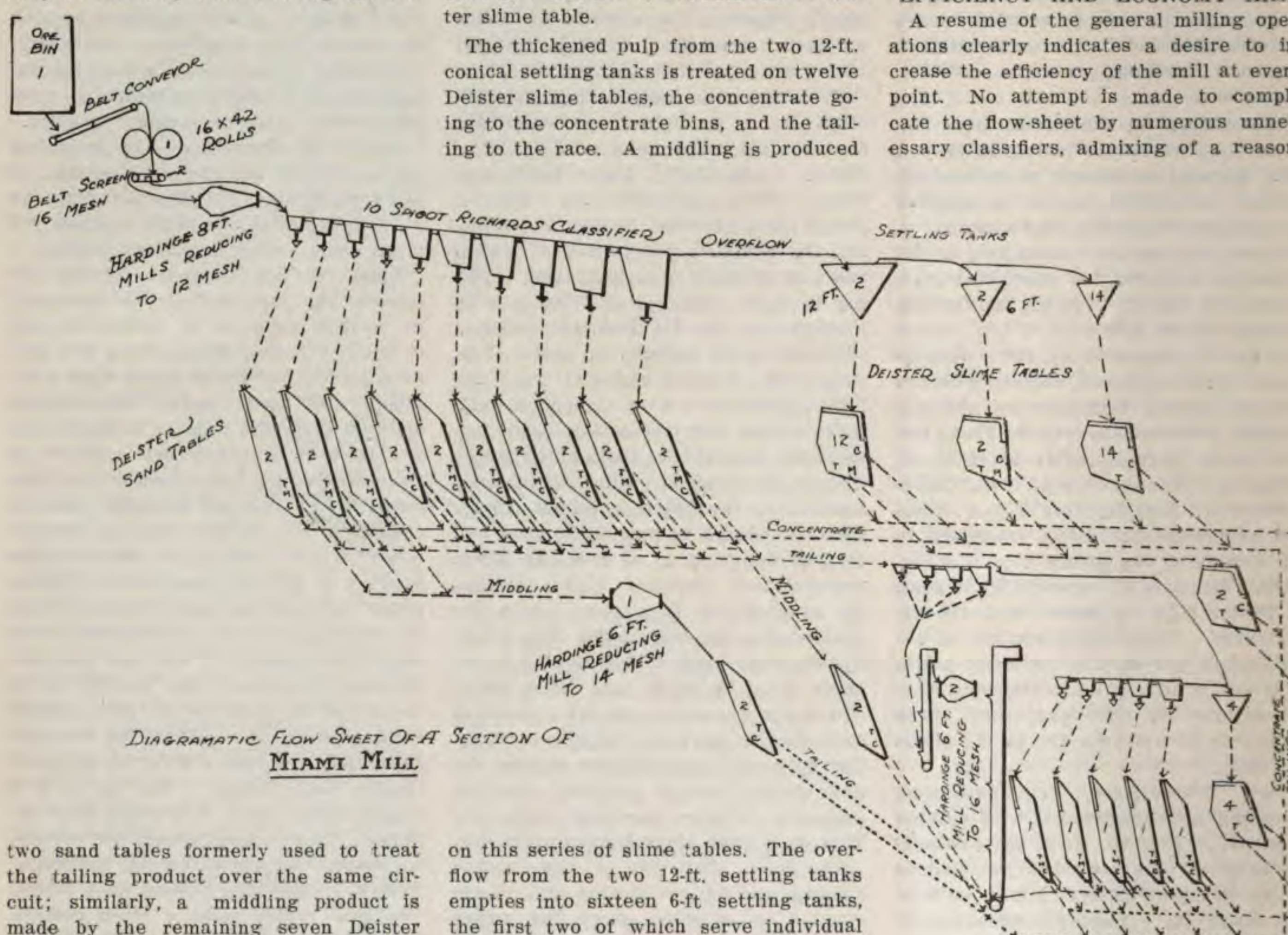
The present flow-sheet considers the treatment of a coarse middling from the three first Deister sand tables in a 6-ft. Hardinge pebble mill regrinding the pulp to pass 14-mesh, then treating on the two sand tables formerly used to treat the tailing product over the same circuit; similarly, a middling product is made by the remaining seven Deister sand tables which is treated on two Type 2, special size Deister sand tables installed on the second floor at the head of the Deister slime tables formerly treating the tailing product from the same series of sand tables on the first floor.

The tailing from the entire series of ten sand tables fed by the Richards classifiers now is subjected to further treatment, as will be noted in the diagram. This retreatment plan considers the classification of all the tailing in a 4-spigot Richards classifier, used solely for the purpose of dewatering, as all four spigots serve a small bucket elevator, the overflow from the classifier going to the large dewatering plant at the foot of the mill. The pulp from the 4-spigot classifier is elevated to two 6-ft. Hardinge pebble mills, regrinding to approximately 16-mesh. This reground pulp is then elevated by a second bucket conveyor to a 5-spigot Richards classifier, each spigot of which serves an individual Type 2, special size Deister sand table, the latter producing a concentrate, middling, which is returned to the 5-spigot classifier, and a tailing.

The overflow from the 5-spigot classifier goes to four 6-ft. conical settling tanks, each of which serves an individual Deister slime table.

The thickened pulp from the two 12-ft. conical settling tanks is treated on twelve Deister slime tables, the concentrate going to the concentrate bins, and the tailing to the race. A middling is produced on this series of slime tables. The overflow from the two 12-ft. settling tanks empties into sixteen 6-ft settling tanks, the first two of which serve individual Deister slime tables which, besides producing a concentrate and tailing make a middling, the last mentioned product combining with the middling from the twelve tables served by the 12-ft. settling tanks and being treated on a series of two Deister slime tables in tunnel No. 2, immediately beneath the slime table floor.

The first tailing outlet is from the group of all the slime tables, the product from the groups of sand and slime tables (with the exception of the last fourteen slime tables on the second floor) being subjected to retreatment as noted in the diagram.



Diagramatic Flow Sheet Of A Section Of Miami Mill

However, in considering the present flow-sheet it will be noted that the treatment of the tailing from the entire series of sand tables in the mill is an improvement which is worthy attention, affording as it does, an extraction of copper from the tailing which otherwise would be lost. The general plan of the plant built to retreat the sand table tailing evidences the only attempt to employ a closed circuit in the entire milling equipment, and, was so arranged because of insufficient space below the main building to permit of an extension of the gravity plan.

EFFICIENCY AND ECONOMY AIM.

A resume of the general milling operations clearly indicates a desire to increase the efficiency of the mill at every point. No attempt is made to complicate the flow-sheet by numerous unnecessary classifiers, admixing of a reasonably clean middling and tailing with new pulp followed by treatment over one circuit, or the regrinding of pulp, tending toward excessive sliming. To the contrary each product, other than the concentrate produced, is subjected to a treatment peculiar to its particular requirement, and best suited to extract the maximum percentage of copper mineral contained from the pulp. This feature is, perhaps, best outlined in the flow-sheet diagram given herewith.

The most remarkable change in the mechanical equipment of the mill has been the substitution of Chilian mills

by Hardinge pebble mills. The conditions obtaining a few months since (when it was deemed advisable by the management to remove the Chilian mills on account of their comparative inadaptability to reduce the pulp to the desired fineness without excessive sliming), led to the installation of the Hardinge mills. The change has, however, been made gradually, a thorough test of the relative merits of both types of grinding machines having been made, under actual operating conditions. The greater mechanical efficiency, and more economical operation of the Hardinge mills led to their adoption; consequently, so soon as the changes can be made in the two other units of the mill now using Chilian mills, Hardinge mills exclusively will be used. Comparing the cost of the lining and pebbles of the Hardinge mills with the cost of steel and screens of the Chilian mills it is said that a saving of 3 cents per ton of ore treated is effected by the use of the former.

The question of an economical water supply for the mill has necessitated the construction of an extensive dewatering plant below the mill to recover as much water as possible from the tailing. Briefly described the plant consists of four sets of large wooden conical settling tanks arranged in series of three each. The tail race empties into these tanks, the overflow going to eighty (80) 12x20-ft. concrete tanks for further clarifying, and the thickened tailing to the tailing elevator pit. This system permits of the recovery of practically 85% of the total water used in the mill.

Local conditions do not permit the easy disposition of the mill tailing; consequently, when the gulch immediately south of the mill is filled it will be necessary to construct a flume to transport the waste material over into the adjoining canyon. In anticipation of this circumstance the company has constructed a 75-ft. tower containing four bucket elevators, which elevate the tailing to a flume distributing to the tailing pond in the first canyon, and will care for the tailing disposal into the second canyon when necessary.

NOT ALWAYS ABOVE CRITICISM.

The Miami Copper Company is, perhaps, the best representative, with the exception of plants at Morenci, of modern mining and milling practice as applied to the treatment of the disseminated copper ore deposits. It has not always been so, but through no fault of the constructing engineers. The Miami Copper Company has not been above criticism, much of it well deserved. However, the criticism directed toward the management upon the ground of extravagance in the matter of constructing a "palatial" ore-dressing plant was unwarranted. A personal visit through the mill will serve to correct any such impression. The mill is, in no sense, "palatial," but merely is designed to effectively care for any future contingency in the matter of material changes in ore-dressing methods, and to care for the present operation of the equipment in the most efficient manner possible. Such action is highly commendable.

During the initial operation of the concentrator, the management considered the treatment of a maximum ore tonnage, apparently regardless of efficiency. In part this action was due to the fact that there existed at the time a large tonnage of ore in the stock pile; consequently, a treatment of tonnage through the mill approximating forty to 100% overload was practiced for a considerable period of time. A reconsideration of this method soon followed, due (1) to the fact that, when the stock pile had been treated it was ascertained that the mine was not planned to output but 3,000 tons daily except by sacrificing a large tonnage of commercial ore, and (2) failure to recover a percentage of copper mineral approaching the saving effected on a normal tonnage basis. In short the mine and the mill were planned to care only for a normal tonnage of 2500 to 3000 tons daily, and an excess over that quantity, as might have been expected, resulted in serious economic losses. The readjustment might, therefore, be said to have been compensating.

Further, the Miami Copper Company has not always in its milling operations been prepared to effect the high percentage copper recovery at present being made. Trivial changes in the practice have been necessary from time to time, but every change made has been productive of satisfactory results. Extremes have been avoided, and the engineers in charge have been careful to preclude the possibility of complicating the mill flow-sheet; in fact, they have evidenced unusual foresight throughout, so that each successive change has tended to increase the efficiency of the mill rather than the contrary.

The general character of the Miami ore necessitated minimum sliming if a satisfactory recovery of the copper mineral was to be effected. Consequently, Burch rigid rolls were installed to care for the first stage crushing, on account of their producing a uniform granularity of the pulp. The uniformly granular pulp from the Burch rolls was delivered to Chilian mills for further regrinding, with unsatisfactory results, as the Chilian mills slimed the product which it was intended to maintain in as coarse state as possible consistent with the liberation of the copper mineral from the gangue. Therefore, in view of this apparent counteraction, the management sought a grinding machine to replace the Chilian mills, resulting in the adoption of Hardinge pebble mills as hereinbefore outlined. These latter mills are now in successful operation, and, beside a marked saving in maintenance, are mechanically more efficient in connection with the fine grinding of the ore, without excessive production of slimes.

Concerning the Burch rigid rolls it might be apropos to state that the rigid rolls employed in the Miami mill have given excellent service, the fact notwithstanding that spring rolls have, in several sections of the mill been substituted therefor. Briefly stated, the reason for the change mentioned was due to the fact that the rigid rolls were not adapted to the handling of heavy overloads—having been designed to care only for the normal tonnage for which the mill was designed. Now that conditions have returned to normal it is probable that the rigid rolls will be reinstalled throughout the mill.

The entire six sections (each of 500-tons daily capacity) of the Miami mill are at present in operation, and it is probable that, later, the three additional units which were to have been constructed during 1912 will be completed, thereby giving the company a nominal milling capacity of 4,500 tons daily.

Miami, operating at its normal capacity of approximately 3,000 tons daily, and treating ore averaging from 1.95 to 2.58% copper per ton, recovers on the average 77% of the copper mineral contained in the ore. It is quite probable that the percentage of recovery will shortly be increased to an average of 80%.

The concentrate produced is shipped to the Cananea Consolidated Copper Company's smeltery at Cananea, Sonora, Mexico, for further reduction. Dependent upon local economic conditions cost of production ranges from 9.57 to 10.61 cents per pound copper.

AN UNUSUAL FEATURE.

An unusual feature in connection with the operation of the Miami Copper Company's concentrator, and which to my knowledge does not exist at any other milling plant in the west operating upon the low-grade disseminated copper deposits, is the circulation of daily reports among the employes in every department clearly outlining the results obtained. Tonnage treated, average head

and tail, together with recovery effected, is given unreservedly. Bulletin boards are conveniently placed in each section of the mill, and the reports attached thereto give in detail not only the results obtained for the entire day, but a segregation into the three respective shifts, comparing the operations for each respective shift of eight hours. Therefore the employe is taken into the confidence of the employer, and aside from his appreciation of the fact, which results in a more satisfactory relation, he is at all times cognizant of what is expected from him and therefore, in view of the information which is at his command, he is better prepared to perform his duty with maximum efficiency. In short, the interest of employer and employe is mutual, and this mutuality carries with it the conviction that the management is equally as liberal in the diffusion of necessary data covering its daily operations, as it was in its expenditure of capital to construct a "palatial," but nevertheless a superior, modern concentrating plant.

IN CONCLUSION.

Generally it is understood that, when the Inspiration mill is placed in commission, and is producing concentrate, a smeltery will be constructed in immediate proximity to the Miami-Inspiration mills to handle the output of that district. This arrangement precludes the construction of a railroad from Hayden principally for the purpose of shipping the concentrate to the Hayden smeltery, and will shut out the Guggenheims from the district, unless they succeed in gaining control of the entire Miami-Inspiration holdings for which they have been negotiating for the past year.

An interesting point in connection with the proposed purchase of the Miami Copper Company by the Utah Copper Company is current, both at Miami and at Ray, to the effect that the Utah Copper Company management would not consider the purchase of the Miami holdings, primarily on the grounds that the milling equipment was inefficient, and the expense of remodeling the concentrator would be too great. Whether credence can be given the rumor or not, it contemplates a very interesting discussion as to the efficiency of any of the concentrating plants controlled by the Utah Copper Company when compared to the Miami mill.

It should be borne in mind that Mr. H. Kenyon Burch, the engineer, who, with his assistants, designed the Miami concentrator, is not a novice in the construction of concentrating plants, but has designed and constructed more large mills of types thoroughly suited to the character of the ore to be treated than have the entire engineering force of the Utah Copper Company. Mr. Burch's mills are as efficient as modern engineering can make them, and his ability along this line is, perhaps, best reflected in the fact that he knows the requirement in advance of constructing and, therefore, when the mills designed by him are placed in operation THEY DO NOT HAVE TO BE REMODELED.

To the contrary, the gentlemen who designed the plants of the Utah Copper Co., Chino Copper Co., and Ray Con. Copper Co., etc., seemingly have no respect for established methods of engineering. Otherwise in lieu of the application of the same general milling plan to the widely different types of disseminated copper ore deposits of Utah, New Mexico, Arizona, and so forth, the mills would have been planned to meet the conditions peculiar to the character of ore to be treated. As it is, the ore must adapt itself to the milling plan rather than the adaptation of the mill to the ore, thereby occasioning a constant remodeling of the mills in order that a recovery of but little more than half the copper content of the ores treated might be made.

Miami is representative of what modern mining and milling practice should be, and great credit is due Messrs. Channing, Burch, Lawton and Gottsberger, and the other engineers who are responsible for the efficient operation of the property. Of particular interest is the marked appreciation of Mr. Burch's engineering ability through the engagement of his services to design and superintend the construction of the new Inspiration concentrator of 7,500 tons daily capacity, a complete description of which will be published in Mines and Methods in a later issue.

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The local daily press a couple of months or so ago gleefully told how the Utah Copper Company had been able to secure several hundred Mexicans to take the places of the strikers on the steam shovel benches of its mines at Bingham. On the tenth day of December every mother's son of them—over 400—quit and left the camp. And the daily papers made no mention of it.

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An Alaska mining news item in a recent issue of the Engineering & Mining Journal says: "The Perserverance stamp mill, four miles up the Silver Bow Basin, was destroyed by fire, December 3. The mine force of 150 men was able to save the powder house and adjoining buildings. The mill, which was an experimental one, will not be rebuilt." Thus it will be seen that no apologies in the near future will have to be made for lack of reports concerning the real, recoverable values—or lack of them—in the ores of the Alaska Gold Mines properties, chief of which is understood to be the Perseverance. The destroyed mill is the one that was to be run—and supposedly was running—to capacity during the development of the properties as a "testing" plant. However, the "big noise," the powder house, was saved.

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Pipes connected with dumps and tanks in mills situated in cold climates should be so arranged that they can be drained after use, especially where used in intermittent work, such as in vacuum filtration of slime.

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It has often been observed on return air-ways, where the air is warm and dry, that the lamps do not burn so brightly and the workmen become dry and thirsty. It is said that the parched air absorbs the moisture from the body, and unless they have ample drinking water, their blood becomes thick and hot, resulting in feverish, painful lassitude. The same warm air, before reaching the lamps has been absorbing water in its journey, and is thus so heavily charged with watery vapor that its oxygen is diluted, which results in dull and sickly lights.

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Although previously considered insoluble in sulphuric acid, even when boiling, it has been shown that platinum is actually soluble in it to a slight degree (Brass World, November, 1912) and that boiling sulphuric acid will dissolve appreciable amounts from the vessels in which it is heated.

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All commercial explosives owe their power of doing work to the expansive force of the great volume of gas into which they are converted at the occurrence of the explosion. The pressure exerted by this gas in the drill hole or other confined space in which the explosion is brought about is what makes explosive substances of value in mining or other industries, and is the primary cause of all those manifestations of energy that follow the firing of a charge. Common black blasting powder, on explosion, produces about 390 times its own volume of permanent gases; 40 per cent dynamite produces about 530 times its own volume of permanent gases; and nitroglycerin produces somewhat more than 747 times its own volume of permanent gases. These proportions of volume of gases to volume of explosive are those that would be found if the gases were measured under normal conditions of temperature and pressure, but at the moment of explosion the gases are highly heated, and therefore tend to occupy a volume much greater than the figures given.

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CONTENTS:

"MANAGING EDITOR" JACKLING

Quoting a long and senseless yarn about the Alaska Gold Mines from the Wall Street Journal, the Salt Lake Tribune of the 13th opens up as follows: "D. C. Jackling, vice-president and managing editor of the Alaska Gold Mines Co., who is in New York, says the company's affairs are proceeding smoothly and much more rapidly than expected." It has been generally known that Mr. Jackling was vice-president of the company, and while it has been suspected all along that he also was "managing EDITOR," the fact that such an official designation had been created for him by the company, was not given out publicly—so far as we know—until the Tribune released it on the date stated. But it's all right; and it sounds all right. Besides, we are ready to admit that the title covers perfectly the most strenuous part of his duties in behalf of the company.

SMOKE MAKERS VS. CITY BUILDERS

It has been shown in these columns by government records that foggy, smoky days in Salt Lake City have been just ten times as frequent since the smelters began operations in the valley as before. A number of the world's scientific authorities have been cited to show just how the smelter dust, fume, smoke and gas work their destruction and increase the smoke and fog over Salt Lake City.

It has further been shown by cost figures of smoke damage, compiled by experts in the U. S. Bureau of Mines, that the average annual damage in cities from foggy and smoky days is seventeen dollars per capita, which is practically two million dollars a year in Salt Lake City. It has been shown by local weather bureau records that an average of sixteen and one-fourth out of twenty foggy or smoky days a year in Salt Lake City are unnatural, and undoubtedly the direct result of smelter smoke, causing a loss of $1,625,000 a year above the natural or legitimate cost of smoke.

Adding to this the State Game Warden's figures of $208,333 a year, as the value of the wild fowls destroyed annually by smelter poisons, we have a charge against the valley smelters of $1,833,333 a year of actual property destruction and additional expense.

Tourists who find here a foggy, smoky unattractive city, spend less time and less money with us than they would in a clean, cheerful city, as interesting naturally as is Salt Lake City; and the demand for business property and city homes is much less than it would be if the smoky, foggy days were diminished, and thus the actual value of our property is below what it rightfully should be.

A "City of Opportunity" must be a "City Beautiful;" a suitable place for handsome homes; a peaceful place for comfort-seeking older folks, and a clean, daylight mart for the opportunity-seeking younger folks; and finally, it must be a place where its own builders may dwell in cleanliness and happiness, with never a diminishing view, or a lack of the fresh air, which taught them to love the place in the beginning.

Salt Lake City is, naturally, just such a place!

The smoke and fogs are unnatural and unnecessary. We deserve them no more than we deserve a pestilence of disease. They can be greatly mitigated if not almost entirely stopped by the removal of the smelters from the valley. And for those who may not know, it should be said, the "hardship" on the smelters to move is really a comparatively small matter, so say those in a position to know. The equipment is outdated in many respects, and it is well known that the added efficiency from modern machinery and methods perfected since the erection of the Murray and Midvale smelters, would probably make it profitable to rebuild the plants for this reason alone, since both have been in operation more than ten years.

The annual toll paid to the valley farmers regularly for crop and stock damage, would cease, if the smelters were removed to the desert west of the Oquirrh mountains; and yet the average distance to the contributing mines would not be greatly affected; and as has been proven by the International plant near Tooele, the usual business of the smelter operation and maintenance, as a rule, need not be transferred from Salt Lake City, nor need Salt Lake City lose any important amount of business by the transfer of the smelters a few miles farther away.

It is probable that enough pressure could be brought against the owners to cause them to voluntarily remove, yet, failing in this, there is already sufficient funds and sufficient public spirit among those interested and not subservient to the smelter business directly or indirectly, to bring the legal action necessary to have the smelters adjudged a public nuisance and force them out of the valley.

Do the people of Salt Lake City and valley want it done? And do they want it enough to SAY they want it?

The business connections of many forbid their speaking their honest minds on such a subject as this, yet there are many who do not fear a boycott or

business strife, no matter what they may say against an institution so powerful as a smelter corporation; and for this reason the editors of Mines and Methods do not expect the open approval of some of the city's most influential persons and institutions, yet the editors wish to advise the people of Salt Lake City that when the proper moral support is given to the anti-smoke crusade, being waged by this magazine, the financial support, already pledged, will be promptly put into effectual action.

It may seem like a calamity to the city to be in the predicament of asking the smelters to move their plants over into the next valley; and yet, careful investigators have found that the sentiment against a further toleration of the smoke nuisance is so great and so earnest, that the loss of business men, and of scores of well-to-do and influential citizens, who will move their homes if the smelters are not moved, is really a far greater calamity, and one productive of absolutely no permanent good to the city, such as the removal of the smelters would be.

Which shall it be, the dominion of the smoke-makers or of the city's home-builders?

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Thirty days ago Carl C. Herman, a guard at the Utah Copper Company's mines, decided to do what he could to make his job perpetual, so he gathered up a lot of giant powder and was making preparations to blow up some of the buildings on the property when a roommate, who became frightened at the amount of explosive Herman was accumulating, reported the matter and Herman was arrested. "The job as an armed guard during the strike," Herman is reported as having said, "was an awful soft snap and I figured that to set off a quantity of dynamite in different parts of the camp would cause the mine owners to think that the strikers were causing the disturbance." A great many "guards" are still employed by the company and, while it seems that there has never been much use for them, as far as preventing depredations by the striking miners has been concerned, there is still apparent justification in keeping some "tried and true" men to watch the rest of the gang.

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P. H. Craven, inventor of the Craven slimer, a device to save the overflow of copper from the tailings, is in Salt Lake City endeavoring to interest D. C. Jacklings, general manager of the Utah Copper, in installing the Craven slimers in the concentrators at Garfield.—Salt Lake Telegram, Jan. 26.

Mr. Craven will sure find some "overflow of copper" in the tailings at the Utah Copper plants.

UTAH COPPER'S DEFICIT

The fourth quarterly report of the Utah Copper Company for the year 1912 was released and made public about the middle of the month. It is a queer document—one that will cause stockholders to do some hard thinking and figuring on what may be expected in the future. When they read the tale of woe leading up to the management's acknowledgement of a deficit for the quarter of \$82,247.90, and the manner in which it is arrived at in the financial statement, they are likely to wonder how much greater the amount would have been had the whole subject of income and outlay been properly covered.

The report shows that the amount of ore produced was 930,595 tons, the assay value of which was 1.104 per cent, or twenty-two pounds of copper per ton. The total yield in copper was 12,906,582 pounds and the total cost of production was 14.83c. per pound. The estimated average value of copper for the quarter was 15.15c per pound, thus showing an apparent profit of the difference between 14.83c. and 15.15c. or 0.32 of a cent per pound. The total number of pounds of copper produced for the quarter multiplied by this difference gives an apparent net operating profit of \$39,273.18, which is given in the report as a milling profit. But just how it is figured that a mill could earn a profit when all other departments of the enterprise managed only to break even, or lose, is not made quite clear in view of the fact that no previous report has ever credited any independent profit to the mills. This alleged profit, divided by the number of tons of ore said to have been treated, gives a profit of only ABOUT FOUR CENTS per ton.

The remarkable feature of this exhibit is that the recovery appears to have been nearly fourteen pounds of copper per ton of ore treated, or about 68% of the total contents of the ore, which compares with an average of less than 60% recovery under the most favorable conditions. This apparently unusual high recovery, however, disappears when the fact is taken into consideration that in reality nearly 1,300,000 tons of ore were treated during the quarter, or about 30% in excess of the amount given in the report, as above stated, the difference being left out of consideration as representing the excessive moisture in the ore due to the unfavorable weather conditions complained of by the management. It is suggested, however, that had not the excessive tonnage been provided so as to give the management the advantage of a maximum load in that part of the plant operated, the profit would most likely have been less than four cents a ton.

Another unfortunate consequence resulting from the Bingham cold weather seems to have been in the necessity for increasing the capacity of the crushing plant to 50,000 tons a day in order to overcome the stubborn resistence of the frozen ore, as it is well known that Utah ores in temperate weather are exceedingly soft and friable. According to Manager Jackling the economic percentage of recovery to be sought in milling practice is that which is determinable only by the tonnage of ore that may be hurtled through the mills. It is therefore probable that when unfavorable weather conditions disappear it will be found necessary to raise the capacity of the balance of the milling plant to correspond with that of the coarse crushing department, the increase to be operative only in favorable weather, reserving the full power of the increased crushing plant to provide normal supply to the present tables when the ore becomes harder by winter frost.

Some of the other questions that will naturally follow a careful, serious reading and consideration of the report are:

Why should the company have kept running at all, when the management knew that to do so would not only result in a direct money loss but also in the utter dissipation of over 1,000,000 tons of ore?

And, if what Manager Jackling has reported during the month is true, namely, that it will require another two or three months to get back to normal conditions—as compared with those which have prevailed from the beginning of October last—why is the property not closed down now?

In fact, is there any excuse for the wanton waste and ruining operating practice that has prevailed at the Utah Copper properties for the last five months, (or from the beginning, for that matter), other than the frenzied determination to escape, as long as possible, the final day of reckoning?

The situation is a desperate one. There seems to be no place into which Utah Copper can edge in order to escape the storm that is gathering. It has been pictured to the world as the "greatest self-contained manufacturing enterprise of the day;" its management has been depicted as the quintescense of perfection, and its engineers the greatest in the world; its mining and milling methods have ben heralded as the acme of applied human knowledge, and the success of numerous other gigantic enterprises fathered by the same and kindred interests have been predicated and built up on the strength and worth of this one. The

completed structure—the handiwork of these "master minds" in the world of engineering skill and high finance—may be likened to an inverted pyramid (with Utah Copper representing the bottom stone) constructed of concrete blocks of huge dimensions containing disproportionate quantities of sand, cement and coarse gravel to the "units" of "water" employed, AND ESPECIALLY WATER.

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PRECOCITY OF GUGGENHEIM'S

The recent purchase of large blocks of Ray Consolidated and Chino stocks by the Guggenheim interests probably has a significance quite different to that which has been attributed to those purchases. About the time of the purchase by the Guggenheims of their first large block of the shares of Utah Copper, together with convertible bonds, by which means the original financing of that company was inaugurated, they also purchased a considerable interest in the stock of the Federal Mining & Smelting Company, of the Coeur d'Alene district, Idaho. It now appears that as a condition of the purchase of the shares of that company they secured a contract for the smelting of the ores to be produced by the Federal mines for a period of twenty-one years. Of course no information was given to the public as to the terms of the contract or rate to be paid for the product of the mine; but the fact that the contract was a most favorable one to the Guggenheims and that it was secured under pressure has been disclosed in the action recently instituted in the United States court in and for the district in which the mines are situated by the majority owners of the stock of the Federal company. This action was brought to have annulled and set aside the existing smelting contract by reason of its excessive bias in favor of the Guggenheim interests. In connection with the legal proceedings it was made to appear that the contract required the payment of $22 a ton to cover transportation to Colorado or Utah points and smelting at the place of reduction, the metals being paid for in the usual way at prices based on New York quotations.

Upon the installation of lead smelting furnaces at the works of the International Smelting Company at Tooele, this state, it appears that many contracts were made for the product of other mines in the locality adjacent to the Federal company's mines upon a basis of $16 per ton, the difference being $6 per ton in favor of the producer, and which, applied to the ores produced by the Federal company, means a loss to that company estimated at $800,000 per annum, wherefore the action referred to was brought with the hope of saving this large sum to the stockholders.

We have shown in a previous issue of this magazine that as a condition to the purchase of the initial block of Utah Copper shares at $20 per share and also the purchase of $3,000,000 of convertible bonds of the company, wherewith to provide funds for the construction of large operating plants, that a contract was entered into by the management of Utah Copper and the Guggenheims whereby the latter, for a period of twenty-five years should receive $6 per ton for smelting Utah Copper concentrates, with an additional price of 10c. per unit for all silica contained in the product above a point 10 per cent below a neutral base—that is, the contract guaranteed that the iron contained should exceed the silica by ten points, in order to entitle the Utah company to the $6 treatment charge. Now, as the silica at all times exceeded the iron contents by twenty-five to thirty-five points the smelting charge at once, it was discovered, settled around $9 per ton; but finally, in order to avoid vexatious litigation which was threatened on the part of stockholders who had not been parties to this contract, the Guggenheims rluctantly agreed that the charge for smelting should in no case exceed $7 per ton, and as the iron was always more than ten points below the neutral base, the price became a fixture at $7 per ton.

At the time this contract was made the Gugenheims were receiving and treating other ores of similar but more refractory character at $4.50 per ton, without time contracts, and were offering a rate of $4 on time contracts. The difference we have shown to be equal to ¾c. a pound on all copper produced by the Utah Copper Company.

In the matter of Ray Consolidated and Chino—both companies being in need of further financing—it must be presumed that the purchases of shares in these companies was conditioned upon long time contracts for the exclusive smelting of the ores to be produced by those properties and that the rates were not less favorable to the Guggenheim interests than were those contained in the contracts with the Utah Copper and Federal companies, before mentioned. Naturally it was to have been expected that taking these large blocks of stock off the market would have had the effect to greatly enhance the price of the shares and thus enable the insiders, as well as the Guggenheims, to unload the burden upon the public; but evidently they have reckoned in this respect without their host, the public having, in the meantime, become most stubbornly and offensively inquisitive in matters of investments of this character.

However, in the case of Utah Copper, the Guggenheims can throw away their more than 400,000 shares of that company and still be several millions ahead by reason of profits on their smelting contract; likewise that of the Federal Mining & Smelting Company. And in the case of Ray and Chino it will be a "cold day," even in that torrid region, when the value of the product is not sufficient to pay the smelting charge, which is the first concern of the Guggenheims, and it will only require a few years at most to recoup their outlay in that direction, even though they should fail to unload the shares so purchased on the public.

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OUTLOOK FOR UTAH COPPER

In an interview with the Boston News Bureau (Feb. 11th) on conditions prevailing at the Utah Copper Company's properties, Manager D. C. Jackling was quoted as follows:

> At the Utah Copper property normal operating conditions are fast being restored, and today we are handling from 18,000 to 20,000 tons of ore per day, and that is a lot of material. * * * For the first three weeks in January we averaged to ship 14,000 tons of ore per day, and for the full month the total tonnage should be 450,000 tons, with a production of somewhere near 7,500,000 pounds. This will compare with 5,975,000 pounds produced in December. * * * The various adverse conditions previously noted put us a little behind in our stripping, and we have been compelled to draw our ore supplies from that portion of the property where the grade is a little under the average, so that I qustion if we get back to a maximum production of copper for two or three months.

On the 12th of this month the Deseret Evening News, quoting a report received from the East, credits Manager Jackling in greater detail concerning the grade of the ores mined than that found in his statement to the News Bureau. We quote from the News as follows:

> During December, when a combination of excedingly unfavorable conditions existed, the grade of ore treated was only 1.10 per cent, yet the company produced its copper at a cost of 12 cents a pound. This has demonstrated that on ordinary metal markets Utah Copper can earn a moderate profit by treating 1 per cent ore.
>
> It is probable that the forthcoming annual report will show that Utah Copper is continuing to increase its demonstrated ore reserves and that it now has approximately 350,000,000 tons.

The foregoing announced increase of tonnage reserves compares with a little over 100,000,000 tons similarly brought forward in the reports for each of the years 1910 and 1911, and indicates a falling off in the usual annual increase of about 50,000,000 tons.

Here we have a frank admission by Manager Jackling of the fact so frequently set forth in this journal, that at no time since the inauguration of steam shovel mining and stripping, has there been any appreciable quantity of com-

mercial ore stripped and available for extraction by steam shovels in advance of the daily requirements of the mills; and also of the further fact that as the work of steam shovel mining has, by exhaustion of the better grade of ore along the Quinn fissure in original Utah ground, been necessarily extended into the territory acquired from the Boston Consolidated, there has been a gradual and persistent decline in the copper contents of the rock, now fully conceded by Manager Jackling, as quoted above.

It has been stated by the management since the strike and adverse weather conditions intervened that, owing to the difficulty in getting experienced steam shovel operators, stripping would be practically discontinued for a time. It is a fact, however, well understood by all persons familiar with stripping operations on the property, that the difficulties encountered in transporting the capping from the top of the Boston Con. mountain down some 1000 or more feet over numerous switch-backs, has made the removal of the overburden to the company's dump field practically impossible from an economic viewpoint; so that the manager has discovered, at last, that it would be more profitable to transport the capping over the main ore-carrying lines to the mills and there have it treated as ore. And herein we find an explanation of the methods by which tonnage in this great property has—in the absence of any development of real ore—been so enormously increased during the years 1910-11, and to which increase—(we are now advised by the item quoted above) there is to be made a further addition of 50,000,000 tons for 1912.

This same system has recently been adopted by the manager of the Utah company in respect to Chino, and in this case we are advised that the manager found that, by adding about 40,000,000 tons of practically worthless rock to the 55,000,000 tons of developed ore containing 2.17% copper the reserve tonnage could thereby be almost doubled and an average of 1.83% maintained for the whole, leaving the mass still of excellent commercial grade and at the same time emphasizing the necessity for an early increase in the capacity of the company's milling plant.

Readers of Mines and Methods will remember that in a former issue attention was called to the absurdity of methods adopted by Manager Jackling—as shown in his annual reports—whereby an admitted thickness of 165 feet of capping on Boston Consolidated ground was averaged with about seventy feet on Utah, thus producing an average for the whole territory of about 105 feet. In this manner Manager Jackling assumed that by averaging a depth of capping—the cost of the removal of which by itself considered was absolutely prohibitive from any economic view—with a lesser thickness on adjacent territory an average could be produced that would make the entire problem of stripping quite feasible.

Now that the shovel operations have finally been advanced into and are wholly confined to the Boston territory, with its excessive thickness of capping, which we are advised is more nearly 200 feet than 165, the impossibility of removing this mass in order to reach the ores of meagre grade beneath with any hope of possible profit becomes at once apparent. And hence, the happy solution of a vexed problem is met in a most masterful manner by adding the greater portion of this capping to the otherwise "stupendous" ore reserves already reported, thereby increasing the amount to 350,000,000 tons and the fact that the grade of the entire mass is entirely reduced to about 1% copper is fully balanced by the increased tonnage. And Manager Jackling wisely shows, as quoted above, that the cost of producing copper from ores of this grade does not exceed 12c. a pound, from which it can be readily seen that a fair margin of profit can still be made as long as the price of copper ranges much above that point. And, as there is still some 900,000 shares of stock unissued, available for emergencies, the promised increase in the dividend rate is not without hope.

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WALKER AND JACKLING CLASH

That versatile blowhard, George L. Walker, is quoted by the Salt Lake Tribune of the 12th as saying:

"In many respects Chino has decided advantages over the other propyhry mining companies. The climate in New Mexico at an altitude of 6000 feet is admirably suited to steam shovel operations, the WEATHER BEING WARM IN WINTER, rarely very hot in summer, with exceedingly little rainfall. The ore never freezes, the distance from the mine to the mill is ONLY TEN MILES and the ore mills freely and readily yields up a relatively high percentage of its values."

The Salt Lake Telegram, of the evening before, offers the folowing official excuse for Chino's poor showing:

The production of the Chino company in January was 3,055,821 pounds of copper, against 3,545,104 pounds in December and 4,117,020 pounds in November. General Manager Jackling, who is in the east, states that this reduction is due to severe winter conditions, and to the difficulty in obtaining transportation facilities. The latter factor has hampered production for the past two months. Only four sections of the mill were in operation in January, although the fifth has been ready for operations since November.

The reader will note that Mr. Walker declares the weather is warm in winter; that the ore never freezes, and that the distance from mine to mill is only ten miles. On the other hand, Manager Jackling declares that the poor showing made in January was due to "severe winter conditions" and to the "difficulty in obtaining transportation facilities."

The paragraph in which Walker is quoted was taken from a long "spiel" in which he attempted to show justification for the investment by the Guggenheims in Chino and Ray Con. stock, evidently to stimulate or help create a public buying movement. The statements of Walker and Jackling would have sounded better had they been sprung less closely together. Such misfit declarations have a tendency to create distrust of the "engineering" ability of both gentlemen, and frighten the "lambs" who might have been heading for the shearing pen.

Alterations in the company's new mill also appear to have some bearing on the subject, rather than "severe winter conditions," as appears from the Boston Financial News' apology for December operations. It says:

"Four sections of the mill were operated continuously during the month, one section being shut down. Alterations are being made on the first three sections which were constructed which necessitate the closing down of one section at a time. The improvements occupy 30 days for each section so that it will be at least two months more before the entire plant is in operation. The fourth and fifth sections, the last completed are now in commission and are giving a high average rate of recovery."

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We find the following reference to the high price to which Alaska Gold Mines has been advanced in a market letter of a prominent Boston brokerage house: "Some are disposed to question the increase in intrinsic values of Alaska Gold as represented by the advance in quotations since its initial bow on the curb market but none question the ability of its sponsors to create a good market." The statement of fact and conclusions reached by the writer seem to be a little at variance. It is not good logic to say that SOME question the intrinsic value of the stock and in the same breath declare that NONE question the ability of its sponsors to CREATE A GOOD MARKET. Had the writer said that, NOTWITHSTANDING the disposition to question the intrinsic value of the stock, as represented in the advance of price, it was realized that the stock was so closely held by the promoters of the scheme that ITS QUOTED PRICE COULD BE PLACED AT ANY FIGURE DESIRED, he would have hit the nail square on the head.

THE TRUTH ABOUT BUTTE AND SUPERIOR

An investigation of the operations of the Butte and Superior company for January, 1913, elicits the information that there has been no marked improvement over conditions obtaining during the months of November and December, 1912, as outlined in last month's issue of this journal. This is, of course, in direct contradiction to the statements issuing from the offices of Messrs. Hayden, Stone and Company, and General Manager Jackling, that operating conditions are greatly improved. However, in substantiation of our statements that there has been no improvement, we present a brief outline of the results obtained from January, 1913, operations representative of actual conditions and derived directly from the Butte and Superior company's records.

During the past few months Messrs. Hayden Stone and Company, through their market letters, and General Manager Jackling, through published interviews in both the local and eastern press, have repeatedly and unreservedly stated that the remodeled section one of the concentrator was in successful operation and effecting an average recovery of 80% of the zinc mineral contained in the mine-run ore. Further, that upon completion of a few additional refinements to that section of the mill the general average recovery would be increased to 85%, and possibly higher.

Having the details of operation from the company's own records, as stated above, we quite naturally take exception to the remarks of the gentlemen referred to, and for the further enlightenment of Mines and Methods' readers, we present briefly in the following paragraph the absolute facts covering the January, 1913, operations:

During the month 18,400 tons of ore averaging 21.14% zinc; 1% lead; 1.8% iron, and 1.07% manganese were run through the concentrator, from which there was recovered 5,604 tons of zinc concentrate, averaging 44.6% zinc per ton, and 70 tons of lead concentrate, averaging 43.8% lead per ton. The average percentage of zinc recovery was 66.77%, and of lead, 28.12%. The zinc concentrate contained 1.73% lead per ton, and the lead concentrate contained 15.8% zinc. The average zinc tailing for the month was 9.45% zinc, according to the record. These figures represent the "doctored" report of the company's operations, and are subject to several corrections which we did not deem it advisable to make, in view of our desire to persent the quantities and amounts directly as derived from the company records. Further, on the basis of smeltery settlement for the shipment of January concentrate, if the net return per ton of concentrate produced is segregated into its component parts the gross value per ton of ore in place in the mine can be determined. Then, deducting therefrom the cost of mining and milling, exclusive of construction account and so forth, the direct production cost per pound of zinc is represented by a deficit of approximately $26,800.00 for the month's zinc output. This state of affairs considers the operation of but one of the "remodeled" sections of the concentrator, and, unless there is a very marked improvement in operating conditions, it would seem inadvisable to place section two (after its complete remodeling) into commission for very obvious reasons.

From what has been outlined concerning the operating conditions at the Butte and Superior under the present management, it is clearly evidenced that the "remodeling" of the mill along the lines of the treatment plan of the Magna mill of the Utah Copper Company has been about as successful at Butte as at Garfield—its absoltue inefficiency having been demonstrated at both plants.

The ore of the Black Rock mine (the principal property of the company's holdings) should yield readily to established methods of ore-dressing practice, and never has there been any necessity for a change in the flow-sheet as originally designed by the engineer who had charge of operations prior to the advent of D. C. Jackling and his associates. Even now Mr. Jackling is beginning to appreciate his error in connection with having remodeled the plant, and has turned the work of readjustment of the situation over to an eastern man, who doubtless will eventually return to the original flow-sheet plan of the mill if he is permitted to exercise rational initiative. We are as anxious to see conditions return to a normal basis as anyone interested in legitimate mining and metallurgical enterprises, but where the dominating interests are represented by engineering talent such as that evidenced by Mr. Jackling, and his associate, Mr. Frank Janney, we hold out no hope for the future.

PASSING OF STOCK CONTROL.

Apropos the brief outline of the physical condition of operatoins at the Butte and Superior property, it doubtless will be of interest to readers of Mines and Methods to have light on the manner in which Hayden, Stone and Company, and the Utah Copper interests financed and subsequently obtained control of the property, and that without having directly expended any capital in the proposition. Taking Butte and Superior as an example of the methods employed by the interests referred to, it readily will be appreciated that Alaska Gold, Chino, Ray Con., etc., were financed and then controlled in the same manner. In every instance the property accepted for financing has been supplied with the necessary capital requirements directly from investments made by the general public. The position of the interests promoting the deal is more clearly defined by their negotiating loans sufficient to care for the convertible bond issue, which advances are made by a few gentelmen "on the inside." The money advanced on the convertible bond issues is not a direct investment, as it affords an absolute recovery of the funds placed and a tremendous profit on the temporary loan upon conversion of the bonds into stock at par when the market price of the latter is made to rise. Controlling the bond issue, then, is tantamount to controlling the stock of the company financed through a convertible bond issue. Therefore, under the circumstances the "insiders" manipulate the stock market to suit their convenience, selling out on a high market and buying in on low market—the public at all times supplying the necessary funds. In that manner all of the properties financed by the Hayden, Stone-Utah-Copper crowd have been handled, and subsequently controlled by them without the DIRECT EXPENDITURE OF ANY CAPITAL WHATSOEVER THAT HAS NOT HAD A RETURN VALUE GREATLY SUPERIOR TO THEIR TEMPORARY ADVANCE OF FUNDS ON THE BOND ISSUE. The outline of the Butte and Superior transaction clearly illustrates this phase of the situation, and is applicable to the other properties hereinbefore mentioned.

In 1911 Butte and Superior had a capitalization of $2,500,000, divided into 250,000 shares of $10.00 par value. Captain Wolvin and associates of Duluth, Minn., held the controlling stock interest in the company. The financial condition was not all that could be desired, and, in view of the desire for a new concentrator at the mine, Captain Wolvin, on behalf of the controlling interests which he represented, opened negotiations with Hayden, Stone and Company for the fur-cidentally obtaining cash advances on the controlling interest stock on his personal account. A substantial reserve of treasury stock remained in the company treasury, sufficient for the financing of the new mill construction, and had Hayden, Stone and Company seriously de-

sired a direct investment in the property, same could have been obtained by the direct expenditure of a few hundred thousand dollars. A direct investment in the enterprise, which would necessitate the expenditure of their own funds, was not desired by them. Consequently, arrangements were perfected for an increase of $1,000,000 additional capital at $10.00 par shares, to be used to cover a convertible bond issue of $1,000,000, certicates convertible into stock at par. Incidentally an option was taken on the controlling stock interest held by Captain Wolvin and associates, their stock having been placed under escrow agreement. Following the usual custom the bonds were offered to bona fide stockholders and refused for very obvious reasons. Therefore, it develoved upon Hayden, Stone and Company to acquire the issue which they did on a basis of 90% of their par value, accepting for themselves and the "insiders" $700,000 of the bonds at a cost of $630,000, less selling commission of $30,000. The remainder of the bond issue (par value of $300,000) was distributed in the payment of the then existing indebtedness of the old company. The transaction placed about $600,000 in the company treasury.

Construction of the new mill then was begun and an opportunity occasioned, through the usual market letter procedure, to increase the market price of the shares. About May, 1912, the stock had been advanced from $9.00 (its price when Hayden, Stone and Company entered the bond issue) to $27.50, and 30,000 shares of treasury stock were sold to the public at the latter quotation. This transaction netted Hayden, Stone and Company about $75,000 in selling commission, and placed an additional $675,000 in the Butte and Superior Company's treasury. In October, 1912, the market price of the stock had reached $37.50, and 30,000 additional treasury stock were sold to the public, netting another $75,000 to Hayden, Stone and Company as selling commission, and placing an additional $975,000 in the Butte and Superior treasury. The financing of the proposition up to this point placed about $2,325,000 in the Butte and Superior treasury, and netted Hayden, Stone and Company on selling commissions approximately $180,000 in cash, at the same time leaving an unsold treasury stock reserve of about 60,000 shares to be used for further financing when required.

At this point attention is directed to the manner in which the "insiders" represented by the Utah-Copper, Hayden-Stone group recovered their original "loan" of $630,000, and incidentally realized a handsome profit on their "investment." Having held control of the convertible bond issue, and with the Wolvin stock control tied up, the stock market price of shares was advanced from $9.00 to $27.50, $37.50, $47.50 and so on to upwards of $50.00. In the early part of the stock advance (created by the insiders") they converted their bonds into stock, and— the public loaded up on it at a high market. It is stated by one of the former principal stockholders that Hayden, Stone & Company cleared for themselves and associates approximately $2,000,000 on the transaction. Having the original controlling interest stock tied up at a comparatively low price, considering the price to which the stock market had been advanced, the "insiders" exercised their option rights and acquired control of the proposition without the expenditure of any funds directly on their part, but entirely upon capital advanced by the public as hereinbefore outlined.

On February 4, 1913, Cap. Wolvin was re-elected a director of the Butte and Superior Company, but on the 6th of the same month he was retired from the board upon the final settlement of his affairs with the new management which resulted in the closing out of his holding of 8,000 shares of stock at a price considerably below the present ruling market price of a little over $30.00 a share. Knowing the property as thoroughly as he did, coupled with the fact that he knew the ultimate value of the proposition even under the most promising operating conditions, his action in the matter of letting the control pass into the hands of the present management in a manner which would net him more capital from closing out his stock on a low market than he could hope to receive in net profits from the mine if he were in absolute control, is fully evidenced.

FINAL SUMMING UP.

With a total working capital of $2,325,000 it seems that further financing will be unnecessary. However, it is generally understood in the Butte district that Butte and Superior under the present management has expended a great part of the reserve capital in the investment of mining properties having, so far as demonstrated, no economic value whatsoever. Further, the expense of remodelling the mill has been considerable and the end is not yet near. No profit has been derived from mining and milling operations, and the tendency is at present to maintain a deficit in operations unless important changes are made in the milling practice.

To avert the inevitable collapse of the entire scheme, the rumor is current (and well substantiated by a recent visit of directors of the American Zinc Company) that a consolidation of the Butte and Superior and American Zinc Company is to be attempted, followed by a flotation of the combined concern through Hayden, Stone and Company, (reputed to control American Zinc), assisted by Thompson, Towle and Company. Also, the acquisition of the Lexington group of mines controlled by F. A. Heinze is under advisement, but probably will be eliminated in view of the fact that the developed ore reserves in that property are refractory in the true sens of the word, and cannot be treated at all by any but established methods of treating complex ores—which precludes any consideration of a Jackling-Janney treatment plan. If further financing of the American Zinc Company, heretofore said to have been operated without profit, is to be effected, it will be well to bear in mind that it does not countenance the investment of capital by Hayden, Stone and associates, but the public will be asked to donate a few million dollars through the inflated stock market prices which will be made for the occasion—much in the same manner as obtained in the case of Butte and Superior, Alaska Gold and others.

The question of present market value of Butte and Superior stock is not difficult to determine from what has been said hereinbefore. The future will show no improvement under the present management. The mine with a life of approximately five years will not afford the Utah Copper contingent of "engineers" sufficient time to complete its experiments to determine a method of efficient treatment which will recover the promised 80 to 85 per cent of the zinc. Remodeling of the mill will require at least that much time, and when finally a return to safe and sane methods of milling practice is effected the greater part of the present orebody will have been several miles removed down the valley from the present site.

Considered from the point of normal operating conditions under an able management, assisted by a capable staff of engineers, the property should return in profits the original $3,500,000 capital investment plus five dividends of 10 per cent each.

In the meantime it appears, according to parties just from New York, that President MacKelvie has labored under the impression that Manager Jackling was effecting a saving of eighty per cent at the Butte and Superior mill, and upon receipt of advice from outside parties that but sixty per cent was the absolute figure, went up in the air. Thereupon Allan Rodgers, mill expert, and two other New York engineers, were sent out to fix matters up—but they will be unsuccessful.

FOLLOWING THE SMOKE TRAILS

Reasons For The "Smoke" And Fog Conditions In Salt Lake Explained. Tremendous Money Costs To The People.

By J. CECIL ALTER.

Twelve autumns ago after passing for the first time through the broad, bright streets of Salt Lake, mounting to the crown of Ensign Peak to get a better conception of the most wonderful picture of the plains, my memories of the stockyards district, Chicago, faded far away as I saw spread out before me the foliage-trimmed, sky-kissed, "New Jerusalem;" a city that lay foursquare in the September sun—yet like the holy city of revelation, it semed to have "no need of the sun, neither of the moon to shine in it, for the glory of God (nature) did lighten it." I had come west seeking the light of a new day—a clear day, and before the neighborly sun closed its eyes beyond the lake at the end of my first day here I was convinced that indeed, as declared the Mormon prophet, "This is the Place!"

View looking southwest from Boston building; note continuous smoke layer over city; light easterly wind; continuous dense fog or "smoke" from Wasatch to Oquirrh mountains south of Salt Lake City; a few tips of Oquirrh mountains showing bright and clear above the valley fog layer; the more southerly Oquirrh mountains are behind the deeper fog or "smoke."

But another day was soon to dawn, dimly, and as the gray, poison smoketrail springing up in birth from the center of the valley, began to curl and entangle its endless self over the valley with increasing density day after day, the dawning of the new days became more and more a "deed of darkness;" a dismal transition from the night to the day.

And so again, recently, as I wandered up the slope, out of the latter-day smoke to the resting place of old on Ensign Peak, north of the city, in quest of the lost "city of high ideals," and looked out upon a billowy sea of smoke and fog. I realized that the loved one had passeu away, into the great beyond—beyond the fog somewhere, discernible only by its faint noises coming up through the gloom.

View taken last month, looking west from top of the Boston building, showing dense fog with top limit well defined, light southerly wind was blowing and has been blowing several hours. The dense fog or "smoke' appears to exist independent of the smoke from large stacks. THE SMOKE FROM THE D. & R. G. SHOPS BURSTS UP THROUGH THE REAL FOG AND IS BLOWN AWAY AS TRAIN SMOKE, at extreme right and left of picture.

It was then my nostrils were cleared of their sulphurous, sooty breath for a spell and mentally I saw the tragic picture of a buried Pompeii, overcome by a brick-built volcano, spewing sulphurous lava fumes; and after witnessing the glory of a golden sunrise over the Wasatch—a picture no longer the property of Salt Lake City—I trudged grimly back into the fog, recalling with great vividness, the similar fate of Biblical Sodom, whose reckless desires for material and sensual advantage had, like the business-getting desires of Salt Lake City, resulted in a rain of brimstone, and a day without a sun.

The terrible truth of this single experience is set forth in the record of foggy, smoky days maintained for forty years in Salt Lake City by the United States Weather Bureau; and a casual inspection of this record in the accompanying table, reveals a tale that is stranger than any fiction, and one which cannot be told too often for the good of the town.

In connection with this table of foggy or smoky days it must be stated that the Weather Bureau officials record only the fog or smoke that is a distinct phenomenon, and makes no special mention of those scores of days throughout the year when all the mountains and most of the valley are obscured by the dull gray, view-deadening haze, confining its entries only to those days when objects beyond a half mile are obscured.

Practically all the fogs recorded from 1891 to 1901 inclusive were of the moist

kind, which occurred largely at night, because of the high barometric pressure, and the general coolness of the layers of air, due to radiation and to the flow of cold air into the valley from the canyons. This sort of fogs are usually of the cleaner, though moister, kind. Such fogs were quite as common in the last eleven years as in the previous eleven years, and the typical morning and day fogs and smokes have been added. The first-named variety of fogs will occur in other valleys and over other cities of Utah quite as readily as over Salt Lake City, and general records by government observers show these to have occurred simultaneously in Salt Lake City, Provo, and Ogden, and other places; but the latter kind: the dirty grimy sulphurous smoke-fogs, are the sole property of Salt Lake City.

Of the 221 fogs recorded in the past eleven years, less than five per cent began at any other time than in the early morning, when the greatest cooling of the smoke and smelter particles took place. They also always occurred after long-continued southerly winds, blowing from the smelters. In general there has been snow on the ground in most of these fogs, to add to the atmospheric moisture by evaporation. If there was snow on the ground and no fog occurred, it was an unusually warm morning, with perhaps a great deal of wind movement. Practically all cold winter months since 1902 when there was snow on the ground showed fogs or "smokes."

There were comparatively few fogs recorded during the winter of 1904-5 it will be noted. That winter averaged 2.2° daily above the normal temperature; and out of the 90 days in December, January and February there were only 23 days when an appreciable or measurable quantity of snow lay on the ground in the city at 6 p. m.

PREVAILING WINTER WINDS

At Salt Lake City for forty years from United States Weather Bureau Records. (Figures indicate miles per hour.) Values for hours ending at clock time stated:

Time.	Direction.	Miles Per Hour.
1:00 a. m.	SE.	5
2:00 a. m.	SE.	5
3:00 a. m.	SE.	6
4:00 a. m.	SE.	6
5:00 a. m.	SE.	6
6:00 a. m.	SE.	6
7:00 a. m.	SE.	6
8:00 a. m.	SE.	6
9:00 a. m.	SE.	6
10:00 a. m.	SE.	6
11:00 a. m.	SE	7
12:00 noon.	S. and SE.	8

Average relative humidity at 6:00 a. m. in winter, 75 per cent of saturation; average temperature, 28 deg.; moisture, actual weight, 1.33 grains per cubic foot of air.

Note—The fogs and smoke nearly always occur during the hours indicated above.

The following winter of 1905-6 was exceptionally foggy. During this period the temperature averaged 1.7° daily below the normal or average temperature; and out of the 90 winter days there were 36 days when more than a trace of snow lay on the ground, and another week or two when patches of snow were observed, to maintain high humidity conditions.

In January, 1913, more fogginess and smokiness occurred than in any other month during the past forty years, there being 18 gloomy days. During these January fogs the wind averaged from one to six miles per hour from southerly directions. It also is of interest to note that from the 9th to the 18th inclusive when only one light fog occurred, the total daily number of miles of wind blowing across Salt Lake City averaged 293; but during the continuous foggy, smoky weather from the 19th to the 31st inclusive, the average daily number of miles of wind was only 105, or only about one-third as much.

The total amount of moisture contained in the atmosphere during our winter mornings, with relative humidities of about seventy per cent and average temperatures around thirty degrees, is about 1 3 grains per cubic foot, by actual weight. Not all of this can be condensed on smoke and smelter dust particles, or absorbed by the hygroscopic sulphur dust or acids, in the free air conditions, yet, if only one-fourth of it appears as visible moisture (which is doubtless 0.3 grains, of new sulphuric acid would be produced for every cubic foot of air from the ground up to the average limit of the smoke and soot. This, it must be remembered, is the amount added to that already contained in the air, thus making the total amounts very great, if it is not regularly precipitated by rain storms, or driven out of the valley by windstorms.

If the hundreds of tons of sulphurous soot suspended in the air over Salt Lake City at any one time were perfectly dry it would cause but a relatively small percentage of the detriment that now occurs. Absolutely dry smoke particles of whatever size they may happen to be, would be very much more buoyant than moisture-coated particles, and would not only float higher and be more thinly distributed throughout the atmosphere and have less tendency to fall in sheets and clouds upon the city, but by reason of their floating higher, would find themselves in air whose movement is normally from five to twenty times as rapid as the movement of surface air. And thus would the dry dust-like soot be carried beyond the city limits before it fell to earth. Moreover, in a perfectly dry air, where no moisture could appear on the smoke particles by condensation, the lower strata of air would contain practically nothing but the coarser, heavier particles; the finer and more troublesome soot and dust occupying the greater altitudes, finding as nearly stable equilibrium high in the air as the heavier particles find in the lower, denser air.

And so far as the smoke particles re-

NUMBER OF FOGGY AND SMOKY DAYS IN SALT LAKE FOR 22 YEARS.

(On about half of these days the view was obscured entirely beyond 1,000 feet; on the remainder, the view was obscured beyond one-half mile; no record of the lesser amounts of smoke or fog.) (From U. S. Weather Bureau Records.)

Date	Jan.	Feb.	Mar.	Ap.	May	Jun.	July	Aug.	Sep.	Oct.	Nov.	Dec.	Year
1891	..	..	..	..	..	..	..	..	..	..	..	..	None
1892	4	4	..	..	..	..	..	..	..	..	..	..	8
1893	2	..	..	..	..	..	..	..	..	..	..	..	2
1894	..	..	..	..	..	..	..	..	..	..	..	..	None
1895	..	..	..	..	..	..	..	..	..	..	..	1	1
1896	3	..	..	..	..	..	..	..	..	..	..	..	3
1897	..	..	..	..	..	..	..	..	..	..	..	..	None
1898	..	..	..	..	..	..	..	..	..	..	1	..	1
1899	..	..	..	..	..	..	..	..	..	..	..	2	2
1900	6	..	..	..	..	..	..	..	..	..	..	..	6
1901	..	1	..	..	..	..	..	..	..	..	..	1	2
1902	8	..	..	..	..	..	..	..	..	..	..	..	8
1903	7	6	5	..	..	..	..	..	..	..	1	10	29
1904	3	..	..	..	..	..	..	1	..	1	..	1	6
1905	1	1	2	..	..	..	..	..	..	..	4	14	22
1906	11	15	4	..	..	..	..	..	..	..	7	3	40
1907	11	3	2	..	..	1	..	..	..	..	7	1	25
1908	6	1	2	..	..	..	..	..	..	5	2	3	19
1909	1	6	..	..	..	..	..	..	1	5	4	2	19
1910	5	1	..	..	..	..	..	3	..	..	4	6	19
1911	2	2	1	..	..	..	..	..	..	..	..	4	9
1912	3	2	1	..	..	..	..	..	..	1	2	16	25

main dry this natural distribution of the coarser and finer particles occurs, but unfortunately, with winter humidities in Salt Lake City of from 65 per cent to 85 per cent of saturation, probably no smoke particles, however small, descends very far towards the earth on its return journey before it is cooled to the temper-

View looking southeast from Ensign Flat, north of the city, showing bank of fog and smoke at right. Taken at noon on a perfectly clear day and very light northerly wind. City Creek canyon in foreground; Wasatch mountains in distance; Fort Douglas in foothills, left distance.

ature of the dew point, and annexes its full carrying capacity of moisture.

Instantly then, do we have the light-obstructing smoke particle of say, one three-thousands of an inch in diameter increase in size to one-thousandth of an inch in diameter; that is, rendering an atmosphere clogged with dry smoke and dust particles from the smelter smoke and elsewhere, about three times as opaque with the moisture, or fog particle added. Of course, in nature, this condition is usually limited to small streams of cold air, or to small regions of quiet air, the fog area growing gradually. In nature it is also true that one dust-moisture particle will unite with another, and those in turn with others, the tendency to coalesce being limited only by the amount of humidity available.

The condensations on the larger particles may not immediately increase their size three fold in low humidities, as it does the smaller ones, yet the increase will soon reach this dimension if there is sufficient humidity available. Therefore, in considering the actual sight-carrying quality of the air over the city, alone, with an air so dry that no cooling dust particle could reach the dew point and collect its moisture load, if we could see an object three blocks away, it is reasonable, in general, to calculate that in a moist air, with all particles collecting moisture, the same object would be obscured beyond one block, or just one-third as far.

Moreover, we have it from eminent meteorologists and engineers, that the unconsumed mineral oils in the fuel smoke forms an oil film around every fog or moisture particle which greatly delays evaporation, renders the fog more tenacious and much more durable than a plain, common country or seashore fog. The moist obscuration, now of triple density, is therefore become an object of far greater permanency and continuity of texture than the former mere mass of segregated, separated, unbonded smoke particles.

The sulphur dioxide gas, rendered so abundant in our atmosphere by the smelters, coming in contact with the moisture particles, instantly forms sulphuric acid, as we have previously pointed out. In low humidities, when there is a dearth of moisture, the new sulphuric acid is in condensed form; but during high humidities, with abundant moisture, the more dilute sulphuric acid naturally results, at first.

However, unless the relative humidity is very close to one hundred per cent, or actual saturation, it is improbable that the sulphuric acid poison is very much diluted. This is because of the great and unquenchable thirst the sulphuric acid and the sulphur dioxide has for water; and where the moisture is in sufficient quantity to render the atmospheric sulphuric acid somewhat dilute, the chemical tendency of the sulphur dioxide is to attach more of its own molecules to the water, or sulphuric acid particle if more are available, thus maintaining a very condensed, or strong grade of acid in the air. Our smelter-fed air seldom goes hungry for sulphur dioxide.

These deductions are made from the statements found in some of the newer and more thorough text books on chemistry showing that "about fifty volumes of sulphur dioxide are dissolved by one valume of water at 15 degrees."

View looking south (down Main street) from Ensign Flat, north of Salt Lake City; southern portion of city lost in dense "smoke" at sunrise; very faint southeasterly wind, causing the fog to creep slowly northwestward over the city. Thirty minutes after this picture was taken the entire city below Capitol hill was lost in the fog. Smoke from business district goes very high compared with residence smoke.

Therefore the significant fact is apparent that if one volume of water can annex as much as fifty volumes of SO_2 gas, making a sulphuric acid molecule for every molecule of water (obtaining the other oxygen molecule from the air) the air containing the water and dust and smoke particles as obstructions will be rendered at least two times as opaque, making objects visible at only one-half

the distance and obstructing one-half the former amount of sunshine, by the mere manufacture of the sulphuric acid; and thus the view is shortened to about one-sixth its original length in clear air.

Now we have seen how the moisture will be a millstone about the neck of every smoke particle, weighting them down into the ground layers of air, and binding them together in a continuous but conglomerate mass in our breathing air. Yet this imprisonment of filth that would otherwise float away or settle in a relatively harmless way, is the mere beginning of the trouble; we not only have the smoke-grime wafted against us and against our clothing and books, but we have it rubbed in, so to speak, for while loose, free, dry dust is difficult to confine on any surface, the moist dirt, or, fog-dust has a peculiar affinity for material objects and it very readily attaches its load to every surface, and, once attached it requires the services of an expert to induce it to loosen its clutches.

The moist, fog-filled dirt clings like paint to everything, from our draperies to our memories. The expert who removes the dirt, removes also a portion of the fabric in the laundry, the moist dirt is that tenacious; clothing, furnishings, tapestries and soforth wear out much quicker against a washing machine than against our backs and in use, and they get it about four times as often as they would without the moist smoke.

But the mere moisture alone is not the greatest problem by any means, for laundries and industrious housewives, with care, can safely chase away a great deal of dirt of even this kind; it is the depredations of the sulphuric acid that are irrepairable and unpreventable. A little atom of dust gathered a little atom of water as a cloak, and this molecule attracted a molecule of sulphur dioxide, and this sulphur trioxide attracted chemically an additional molecule of oxygen and pure poisonous, penetrating sulphuric acid was formed, and this sulphuric acid, carried about by the original dust carrier, or in many cases traveling alone (perhaps incognito to be transformed to sulphuric acid by moisture from the receiving surface), alights on every surface, seeking whom and what it may devour.

Mr. H. M. Wilson, an engineer in the United States Bureau of Mines, writing recently in the Iron Age Magazine, says that in addition to the mortality increases where the sulphurous content of the smoke is great, and in addition to the losses from dry goods of all kinds, library books and office records, from the mere dirt, "the vast amount of painting and renovation rendered necessary by the caustic action of the sulphuric acid in the smoke upon all paint, iron and brass work," is considerable; and Mr. Wilson was writing only of cities which have to contend with the sulphuric acid from the coal smoke, whereas we, in Salt Lake City, have from five to twenty times as much sulphurous matter in our air, as a rule, to blight and poison and devour.

If the air were so dry that the smoke particles in cooling would not, ever, reach the dew point, practically none of the disastrous results would occur; yet with humidities of about seventy per cent on winter mornings as a rule, and dew point temperatures of from 20 to 25 degrees, the moisture units on the cooling smoke particles are quite sure to occur to a more or less extent, and forthwith, the heavy charge of sulphur dioxide gas, always in the air, begins the coalescing, and the manufacture of sulphuric acid, the deadly poison, upon the dust particles. And as has been previously pointed out, some physicists have claimed that the sulphur dioxide will combine with the invisible vapor, not yet condensed, just as our garments will take up moisture from the invisible vapor on a moist day, thus forming the sulphuric acid independent of the fog unit.

But omitting this last theory, plausible as it is, we find the sulphur to be responsible for a very large per cent of the obscuration, and for a still greater per cent of the final destruction of property.

A great deal more washing of fabrics is needed, as well as more cleansing of all cleanable articles; and as the tiny bits of cotton or wool fibre from the fabric break off, and the garments, or bedding, or carpets, or upholstery, or drapery or tapestries begins to "wear out," we realize that the life of the article is mysteriously shortened by what appears to be the laundering or the unusually vigorous methods necessary for cleaning; or by fading or actual decaying, yet the terrible fact is ever before us: the goods is being partially eaten by the ever-present sulphuric acid!

The laundry rubbing, even in the dry cleaning processes on the more precious garments and fabrics, does produce much wearing, but it does not wear several threads off at the same place, resulting ultimately in a hole; nor does it cause a garment or a fabric to pull apart, or go in holes under very slight stress, after having been laid away apparently clean from the clothes line—but in reality splotched with sulphuric acid deposits.

Much evidence has been introduced in courts and elsewhere showing that the galvanized coating of wire fencing has not only been corroded and removed by sulphuric acid deposits from the atmosphere, but that the wires have been so seriously acid eaten that they have fallen apart. And if these things be true we cannot blame the salesman, shopkeeper, or even the laundry for the short life of a shirt-waist that has waved and beckoned from a clothesline to every passing particle of sulphuric acid on a smoky, foggy day; or for the short life of an expensive window curtain which has acted as a screen or filter for great quantities of sulphurous soot, in the air we are trying to introduce into our library or bedroom for ventilation purposes.

When the threads of the curtain "break," before it has been cleaned, it is not because it has rotted down in the

Looking southwest from Ensign Flat, north of City. A light northwest wind for one hour had not only swept the city perfectly clean but filled the entire south end of the valley with the "smoke," thus obstructing the view beyond Granite. Picture taken at noon. The northwest wind was obstructed by the Oquirrh mountains on the west side of the valley, permitting the smoke from the smelters and elsewhere to obscure the range, except at extreme north. The heavy smelter smoke hangs low, finding its level always below the mountain tops.

ot by any means; the dirt has (sulphuric acid) and they cut as as a two-edged sword; it is more as than moths, and more certain in its destructive work wherever

oking southwest by west from Granite Stake House, four miles south of city showing the pretty but poison-laden veil of smelter smoke from the Garfield draped along the Oquirrh mountains; the valley, almost entire, was perfectly n a good northwest wind, except as shown along the west side, where even a rind cannot entirely dislodge the smoke. The view shows about one-half the h mountains from the north end.

its, though in many cases the dirt uins the article before the final of the sulphuric acid.

sulphuric acid is quite heavy, red to air, like most fluids in a divided state, the larger parti- it float naturally nearer earth, as larger dust particles; and since strata there is almost no vertical nent of air motion, these heavier es of sulphuric acid flowing leis- along horizontally with the fog, ly disguised usually, as a smoke e with a "jag" on, are the specks ion that come most frequently in t with our property.

e disease and discomfort in the body are about as elusive as any- imaginable that we have to deal physicians as a rule are frank to that there is some powerful poi- city smokes or fogs, some stating t reserve that the poison is the sul- acid, if its identity may be traced results.

said to cause an intense smarting eyes in some people upon emerg- ldenly into a well-laden strata of ric acid- carrying air; persons d with nasal catarrh complain that "clammy" foggy weather, their membranes often become in- irritated and while this is often be the result of the sudden in humidity, there appears good to believe that if the sulphuric articles in the air will eat gal- vanized wire fencing in two, the small amount of it coming in contact with the nose membranes might also make itself known there.

But we breathe down into our lungs

Not all the smoke goes through the smelter stacks. This scene may be witnessed every few minutes at the Murray smelter.

and the poison passing the nose must finally reach the lungs, and of course gets in its work on every surface. Many folks complain of irritating coughs in foggy weather, and usually attribute it to the "dust" in the air, though these same persons do not cough when carrying coal, or cutting kindling, or autoing along dusty roads. The real trouble would seem to be in the irritating sulphuric acid.

Again to quote Mr. H. M. Wilson from the Iron Age magazine, "One of the principal ingredients of smoke is sulphuric acid, and every dweller in a smoke-laden community must each moment take into his lungs this powerful poison." He quotes eminent physicians of Europe and America as saying, "The death rate from all lung diseases is largely increased, and tuberculosis gets in its deadly work in half its usual time." Now if these terrible things are true in average cities (he was speaking of all large cities) how much more potent must be the sulphuric acid in such quantities as exist in Salt Lake City?

Must this become a city from which fresh air excursions will be made out into the uncontaminated mountain air to rest, refresh and rejuvenate child-lungs and eyes, and a city to be avoided by every person of whatever age who appears to be troubled by the smoke of other cities?

This same government official, Mr. Wilson, also quotes the city park commissioner of St. Louis as saying that his shade trees, both the evergreens and the hardwoods, were being suffocated at the rate of five per cent a year, saying that all the older trees would be gone within twenty years because of the dearth of sunshine and the caustic action of the sulphuric acid.

And it is a well known fact that outdoor flowers in Salt Lake City are not only often imperfect, but dwarfed because of the poisonous ingredients from the air; and the leaves of all trees are more or less seared by the sulphuric acid, especially in late summer, after several weeks of quiet fair weather, when the sulphuric acid is permitted to accumulate on the moist leaf and plant surfaces; thus it is manufactured upon the spot where its subsequent destruction takes place.

Of the many ways in which financial loss results from smoke, none would be so great without the sulphur. The obstruction of the sun's rays, causing the use of more artificial light, less efficiency of employees, and so forth, would be less because the sulphuric acid is an obstruction just as is any other particle. The great loss to library books, office records, and the like, would be far less if the grime did not contain the staining, discoloring and devouring sulphuric acid.

Mr. Wilson, quoting official figures,

shows the annual loss from smoke and resultant influences in Cleveland, Ohio, to be $12 per capita, and in Cincinnati, and Pittsburgh to be $20 per capita. The values for all large cities show an average of $17 loss for every man woman and child residing in cities. It will not be forgotten, however, that this is a calamity which very rarely befalls the small city or the country town.

Now it is manifestly too conservative to place Salt Lake City in the list as an average for smokiness in these latter days, and probably a percapita loss each year from smoke and sulphuric acid here would reach $25 or even $30 considering all results. However, to be as conservative as possible in our reckoning, let us assume the Salt Lake City loss to be no more than the amount shown in the "average" cities of the United States, or seventeen dollars per annum per capita.

At the close of January, 1913, an estimate of our population made by the Salt Lake Tribune from records of the public service corporations and others, was about 115,000 people. At seventeen dollars each the total annual loss is practically two million dollars.

With this fact in mind, not forgetting that we have placed it as low as possible, let us return to the table of smoky, foggy days. Twenty-five gloomy days occured in the first eleven years and 221 in the second eleven years. With an increase in the number of foggy days proportionate to the population and coal consumption increase of 70 per cent, we would, normally, have had 42 instead of 221 foggy days in the second eleven years, as previously pointed out. The excess of 179 foggy days, or sixteen and one-fourth per year, has plainly been the result of the smelter dust and sulphuric products.

Now it is well known that there is no smoke damage on bright clear days; that when smoke rises high and is blown rapidly and does not accumulate in quietude in any portion of the city, even when it is not consumed properly. That is, there is no measureable loss from smoke which is not forced groundward and held in masses by moisture, winds and other influences, against ourselves and our property, and with such denseness as to diminish the sunshine.

Therefore, we arrive at the significant and indisputable fact that our loss of two million dollars annually is very largely confined to the foggy, smoky days, and so far as properly placing the responsibility is concerned, we can assume with perfect fairness that the loss be divided into units presented by the foggy days, exclusively, as observed and recorded by the U. S. Weather Bureau.

The twenty dirty days per year (since 1902) entailing the loss of two million dollars, is $100,000 for each and every day on which a fog or a smoke were recorded in the government records. And we have seen that the smelters are solely responsible for sixteen and one-fourth of these days in each of the past eleven years, which gives a loss from the sulphurous spouting smelters alone of $1,625,000 each and every year, probably varying with the number of foggy days from one-half this value to twice this value.

The smelter fumes continue their depredations throughout the farming communities of the valley, being caused especially from the Murray plant, but partially, it is said, by the "muzzled" Midvale plant. And while the damage is probably less to crops and livestock than formerly when arsenic-producing ores were handled more abundantly; and while prompt settlement is usually made with the individual for most of the damage to crops and domestic animals, there is no compensation granted for the loss to the public for the valley shade trees; the trouble said to be caused by the sulphuric acid deposited on fruit which is sold in the local markets and is reported by some as being the probable cause of certain stomach and intestinal disorders; and, perhaps more important, the damage to wild fowl and game birds.

Fred W. Chambers, state fish and game commissioner, estimates that 5,000 000 wild ducks died in the marshes around Great Salt Lake during the past three years. A dozen or so of these fowls were taken to the pathological laboratory of the United States Bureau of Animal Industry, and under the direction of Dr. J. S. Buckley and Dr. J. H. Mohler, were carefully examined. Efforts were made to infect live animals, birds, and ducks with cultures from the dead ducks, but the "Disease" could not be reproduced artificially, and thus it was proven not to have been caused by a micro-organism and not to be transmissible. The irritation of the intestines, or the catarrhal condition, was then reported by Dr. Buckley (in a letter to Mr. Chambers, and another to Dr. M. R. Stewart of this city) to be "due to inflammation of the alimentary tract caused by sulphuric acid."

As pointed out by Dr. Stewart and Mr. Chambers, a great deal of sulphur trioide accumulates on the ground during the dry weather of summer, and much larger quantities of the heavier-than-air sulphur dioxide gas in the valley air, so that the first good rain of autum produces vast quantities of sulphuric acid, which attaches itself to every object and wisp of vegetation throughout the valley, and forms a coating over all quiet water surfaces. And thus the ducks are poisoned by millions.

Mr. Chambers explains that many folks would be glad to pay from 20 to 40 cents apiece for good ducks to eat, and they should therefore be worth from 10 to 20 cents each in the marshes if a bird in the hand is worth only two in the marsh; but at his most conservative value estimate of twelve and one-half cents as food to the state, we find the deadly toll of the smelters from our game bird losses alone in three years of $625,000 or $208,333 a year.

This sum combined with the public damage in Salt Lake City, alone, disregarding the unpaid-for damages elsewhere in the valley, makes an annual charge against the sulphurous gases and solids from the smelters of $1,833,333.

And with this annual load upon her, can a "Pompeii" be unearthed; or can a "Sodom" breathe again the fresh air of the mountains?

———o———

Mercury is but slightly acted upon by sulphuric or hydrochloric acids, but is readily soluble in nitric acid.

———o———

What has become of the flock of electrically-operated steam shovels which the papers several months ago said the Utah Copper company was going to install at its Bingham mines?

———o———

It was reported here about the tenth of the month that the Utah Copper mills handled 18,000 tons a day for the month of January and that the output of copper would be only about 50 per cent of what it ought to be from such tonnage But, what of it? Whose business is it, anyway?

———o———

According to the annual report of the Guggenheim Exploration Company, there has been no change in the amount of Utah Copper shares owned, which indicates that they could not sell and would not buy. The 405,504 comprising the Guggenheim holdings, according to the report, cost an average of only $22.64, so there is still a chance to break even in that stock—PROVIDING THE PUBLIC CAN EVER BE INDUCED to see its tremendous "INVESTMENT" advantages. Besides, it should not be forgotten, as repeatedly explained by this magazine, that the smelting contract under which the Guggenheims treat the Utah product provides an additional profit, above current charges for treatment, equal to about ¾c. a pound on the copper produced—"alle same" Federal Lead.

RTINENT OBSERVATIONS ON UTAH COPPER COMPANY

By JAMES O. CLIFFORD.*

ining properties of the Utah Company consist of about 730 patented mineral land in the mining district, considered to the largest areas of low-grade re mineralization in the world. ting and development in the as been more persistently fol- the Utah company than by any erests owning extensive groups claims in the mineralized area erred to; consequently, to date, pany, according to the manage- ports, holds first place in point b'e ore reserves. However, in he peculiar structural relations ck series, and the consequent on limitation of the zones of l sulphide enrichment, it is quite that other mines will be de- in the near future which, in onnage and relatively high cop- nt thereof, may be quite equal operties of the Utah company.

m Canyon is a district of com- rough topography. The cen- tain wherein the principal min- rties of the Utah company are defined by two deep canyons s Upper Bingham Canyon and k, respectively. The former the north, the latter to the , joining together at a point ely below the Bingham & Gar- vay station house to form main Canyon, which continues north- several miles. The approxi- vation of the mountain men- ove is 1,000 feet above the can- s, the average slope of its side rty degress from the horizontal. n this mountain that the Utah Company confines its steam erations.

eas of secondary sulphide en- in the Bingham district invari- confined to zones of intense n, and it is along one of these mmonly termed the Quinn fis- t the principal mining proper- he Utah company are located. of brecciation has a width vary- 200 to 800 feet, with a general width throughout its length of feet. Numerous minor fissures it but they are of importance only insofar as they represent lines of enrichment of no especial magnitude. Several cross fissures cut the Quinn fissure area, but apparentely they are confined to the extreme northeastern limit of that zone; consequently they intersect at a point without the limits of the Utah company's ground.

The Quinn fissure, as it is called, has a traverse of northeast by southwest, cutting obliquently across the central mountain before mentioned and passing out of the mineralized area controlled by the Utah Copper Company. Its productive length within that company's property is probably 3,000 feet.

As state above the limit of secondary enrichment (to which result the ore bodies of the district are due) is confined to the zones of sulphide enrichment; therefore, the productive property of the Utah Copper Company is limited in point of its commercial orebodies to the extent of the Quinn fissure zone within its confines; allowance being made, however, for the minor parallel fissures, though they are of no especial importance.

The orebodies occur as low-grade disseminated copper deposits within the intensely brecciated area, the values decreasing outwardly from this limit into barren rock. The principal copper mineral is chalcocite occuring as concentrations along the minute fracture planes of the brecciated area, and as minute impregnations of the rock itself. The general average copper content of the Quinn fissure limit of brecciation is probably about 1.7 per cent per ton, though frequently lines of especial enrichment are encountered in which the copper content will reach 3 per cent and more. These orebodies are overlaid by a capping, particularly with reference to the Utah company's ground, ranging from eighty to 160 feet thick. This capping is in part leached material having no economic value, even though it contains in some instances 2 per cent copper as carbonate.

AS TO TONNAGE AND VALUES.

Prospecting and development of the Utah Copper Company's mines has been accomplished by underground work and churn-drill operations, resulting in the development of 214.61 acres of mineral ground to an average depth of 480 feet—according to the management's report of April 26, 1912. Within this area there is said to have been delimited an orebody containing 301,500,000 tons of ore, of which quantity 229,830,000 tons were fully developed, and 71,670,000 tons partially developed. Further, the report states that "the above mentioned tonnage of developed and partially developed ore includes about 26,790,000 tons of partially developed ore in the slopes of the steam shovel workings." It is quite apparent, therefore, that no line is drawn between leached material having no economic value, and ore. Certainly if this material in these steam shovel slopes has not been definitely determined to be ore or capping, and is to be classed as "partially" developed ore, the suggestion is in what manner did the management correctly determine its "fully" developed ore reserves to a depth of 480 feet beneath the surface?

However, the management's report as above stated, then segregates the various tonnages of developed ore according to their relative copper content, the figures therefore being as follows: 62,040,000 tons averaging 2.0 per cent copper; 92,130,000 tons averaging 1.6 per cent copper; 75,660,000 tons averaging 1.3 per cent copper, and 71,670,000 tons averaging 1.28 per cent copper. From these amounts the management calculated the general average copper content of the 301,500,000 tons of ore to have been 1.532 per cent, or, after allowing 0.032 per cent to cover losses in mining through the admixture of waste with ore, the resultant figure was placed at 1.5 per cent.

Although a very limited allowance has been made for reduction in average metal content through the mining of waste material with the ore, there is not contained in the statement any allowance whatsoever for the loss of ore in mining, which, at the least calculation, would be a very considerable tonnage. Evidently it is assumed that the entire 100 per cent of ore developed will be mined without any loss whatsoever.

In practice, however, the mining of ore, either by underground methods, or steam shovel operations as they are conducted at the Utah properties will result in the admixture of waste material with the commercial ore in the amount of not less than 10 per cent, thereby reducing

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the general average grade of material to be mined from 1.532 per cent copper per ton to 1.379 per cent. Therefore, it will be apparent that the general average copper content of the 301,500,000 tons developed (no deduction being made for loss of ore in mining) will be 27.58 pounds per ton in place of 30.63 pounds per ton based upon the higher figure wherein this contingency is not allowed for.

In this connection it will be noted that, assuming the correctness of the management's distribution of tonnages according to specific copper content, the general average of grade of the 229,830,000 tons is 1.609 per cent copper, and the additional "partially" developed ore, amounting to 71,670,000 tons, has an average content of only 0.640 per cent copper per ton—not by any means commercial ore in the Bingham section. It will be assumed in this instance that the 10 per cent reduction in average copper content of the ore will offset the loss of 10 per cent ore in mining. Were this not allowed in the above calculations the actual recoverable tonnage of commercial ore would be reduced from 301,500,000 to 271,500,000 tons, and if a further reduction of 26,790,000 tons be made to cover the "partially" developed ore in the steam shovel slopes (which consists of about equal parts of barren leached capping, and carbonate ore not readily amenable to treatment) the absolute tonnage available would then be 244,560,000 tons containing an average of 31.02 pounds copper per ton.

The development of large ore reserves by the Utah company seems to have been a matter of simple arithmetical calculation, and, assuming the actual occurrence of a well-defined body of copper ore containing a stated tonnage of material of commercial grade, it is not a difficult matter to add thereto a given tonnage of practically worthless material containing a negligible copper content, and thereby to increase the total number of pounds of copper so that, while the quality of the original copper ore fully developed will be reduced to percentage content by the addition of the practically barren material, the total tonnage computed on the basis of its average content of copper will return a greater number of pounds copper in the aggregate, and still be of commercial grade. This feature is best illustrated by what has been said in earlier paragraphs of this paper.

However, using the Utah management's figures, it will be noted that if 229,830,000 tons of 1.609 per cent copper ore contain 7,396,920,000 pounds of copper, and we add to that amount the 71,670,000 tons of 1.28 per cent copper ore, containing 1,834,752,000 pounds of copper, the following results are obtained: The tonnage has been increased 31,2 per cent with an attendant increase of 24.8 per cent in total number of pounds copper, occasioned by a decrease in average copper tenor of the ore of only 4.78 per cent. Similarly, we can assume that the 71,670,000 tons of material contains no copper, in which event the average corrected copper content of the 301,500,000 tons will be reduced but 22.3 per cent as compared to an increase of 31.2 per cent in tonnage.

The above outlined statement of a means by which tonnages are increased is but one of many, but will serve as an illustration of how ore reserves are determined by the Utah management. Dependent upon the grade and quantity of the best ore in the mine, almost any series of results can be obtained whereby any desired increased tonnaged of lower grade ore may be "developed." Either practically barren rock, or material of no commercial value may be made to appear as ore of definite grade, but the result of such practice is always reflected in some other phase of operations—for instance, in the concentration of the ores. That phase of the operations will be discussed further along.

MINING AND STRIPPING OPERATIONS.

According to the Utah Copper management's report of April 26, 1912, covering the year ended December 31, 1911, the average thickness of capping overlying the fully developed ore-bearing area of its mining properties is one hundred and five feet. Removal of this capping was commenced in the summer of 1906, and to January 1, 1912, 33.52 acres had been completely stripped, which, on the assumed basis of 1,400,000 tons of developed ore to the acre, was equivalent to the placing available for mining by steam shovels 46,928,000 tons of ore. Of that quantity of ore there had been mined to January 1, 1912, (according to the management's statement) 15,885,521 tons, leaving in excess of 31,000,000 tons available for future operations—several years supply for the mills.

Now, in this connection, it is pertinent to observe that during the five and one-half years of stripping operations the company has removed the equivalent of 26,235,373 tons of capping from 33.52 acres of mineral ground, of which quantity of capping 11,337,256 tons were removed during the year 1911. Therefore, assuming that future stripping operations will be conducted on the same scale as during the 1911 period (12.65 acres per annum) it will require approximately 14.31 years to remove only the capping directly overlying the orebody from the remaining 181.09 acres of developed ore which it has been the stated purpose to mine by steam shovels.

The interesting part of the stripping operations lies in the fact that, in order to strip the 33.52 acres hereinbefore referred to, it was necessary to remove an average of 233 feet of overburden throughout that area, nor were operations confined to the section most heavily capped, but to the more favored sections where the overburden was lightest. This question of stripping will, however, be more fully covered in a later paragraph.

Both surface and underground methods of mining are conducted by the company and, according to the management's report for the year ending December 31, 1911, 4,680,801 tons of ore were mined. Of this quantity 26 per cent (1,217,008 tons) was mined from underground workings, and the remainder, 3,463,793 tons, by steam shovels. In view of the available area stripped for steam shovel mining it does not appear reasonable to expect that the company would continue its underground work in view of the relatively higher (?) costs accruing therefrom. To continue, it is noted in the statement of mining costs, that the average cost of steam shovel mining for the year 1911, was 33.73 cents per ton, of which amount 9.12 cents was charged to cover the cost of prospecting (?) with churn drills and of stripping expense, leaving a net cost of 24.61 cents per ton of ore mined by steam shovels. Similarly the average cost of underground mining was 68.35 cents per ton, of which amount 15.66 cent per ton was charged to cover the cost of underground development. From these figures the management computes the average cost per ton of ore mined by both underground and surface methods at 31.98 cents, an amount in excess of the costs at the Ohio Copper Company's mines, where all ore mined is by underground methods, and the relative tonnage is but one-tenth that mined by the Utah company.

FAILURE OF STEAM SHOVELS.

Steam shovel mining at the Utah Copper mines is a failure insofar as its advantages over underground mining methods are concerned, and tacit acknowledgement through a continuance of underground operations and preparations to push the work more rapidly during the coming year. Though the company had stripped an area or 33.52 acres to January 1, 1912, which, according to reports by management, contains more than 31,000,000 tons of ore available for steam shovel mining, (equivalent to about six years supply for the mills) there seems

to be urgent need for underground mining of ores to the extent of twenty-five to thirty and more per cent of the total tonnage derived from the property and shipped to the concentrators. With the underground development under way at present the mine will be prepared to output more than thirty per cent of the total tonnage required, and it is said that later the underground development will be completed to care for the entire tonnage requirements of the mills.

It is impossible in the present paper to do more than outline briefly the conditions obtaining at Bingham with reference to steam shovel mining methods, and to point out a few reasons why that method is impracticable and apparently on the verge of abandonment. Later a more detailed article will be prepared and published.

Among the many conditions necessary to the practical application and economical operation of steam shovel mining are that the area of orebody to be stripped shall be of such nature that the quantity of material to be stripped shall bear at the maximum a ratio of not more than 1:1 to the quantity of ore to be removed. Any increase over this proportion of course correspondingly increases the cost, and it is desirable that the ratio of capping to ore be less. Other conditions are (a) that the slope of area to be stripped be of low degree consistent with the length, breadth and thickness of the ore deposit; (b), that the relative line of capping to ore be well defined, and further that the thickness of capping be not subjected to great variations over short intervals of space; (c) that the two dimensions of greatest extremity shall be the length and breadth, the width being of a minimum consistent with the others; (d) that ample dumping ground for waste material be available and close to the line of stripping, thereby reducing the length of haul; (e) that minimum railroad grades for the removal of waste and ore obtain; (f) that the bench series continue in descending scale, that is, maximum stripping at greatest elevation—ranging from the top to the bottom; (g) that bench slopes be maintained at a vertical height not exceeding in ordinary practice fifty feet. Numerous similar conditions might be outlined but they will not be considered now.

Conditions at the Bingham mines are not adapted to steam shovel mining methods. The orebody is confined to the limited brecciated zone hereinbefore mentioned known as the Quinn fissure, the total width of which at its extreme limit would not exceed 800 feet, or representing less than one-third of the face of the mountain at that point. The average slope of the mountainside is thirty degrees, covered with wash to the depth of from seventy-five to more than two hundred feet. The limited width of orebody is capped by overburden throughout its length the average thereof ranging from eighty to 160 feet. The average depth to which the orebody has been developed within the Quinn fissure zone is stated by the management to be 418 feet. The conditions, therefore, are in no way conformable to those necessary to the successful and economical operation of steam shovel mining.

Commencing its operation nearly seven years ago the Utah company began stripping the orebody at the base of the mountain, and gradually extending the bench series upward toward the crest. The result of this practice was that in view of performing greatest stripping at the base the relative angle of mountain slope was increased. Later a series of fifteen terraces of uniform average slope and height were run, completing a series of bench-work from the base to the top of the mountain. However, stripping was confined principally to the lower terrace so that in lieu of reducing the mountain slope it gradually was increased. Recently it has been found necessary for maximum stripping to be conducted on the top-most terraces to prevent a further increase in angle of slope, and incidently to permit operations on some of the lower benches which, heretofore, have been unable to withstand the pressure resulting from a too high slope of bench and have caved.

Steam shovel mining of ore is confined practically to one area of very limited extent and known as the "shovel pit" at the base of the mountain. This pit undercuts the first terrace, making its vertical distance, corresponding to the heavy angle of slope, in excess of 325 feet—which precludes any further operations therein until a reduction of this bench has been made. In view of this circumstance the area immediately adjoining the first terrace has been sunk to a depth of fifty feet below the average level of the old pit, mining being done therein on the order of open-pit methods. The limit of the open pit operations have, however, reached a maximum depth insofar as railway haulage of ores therefrom is concerned, to haul one 60-ton carload of ore from the limited area mentioned requiring from one to two locomotives. Consequently, if operations are to be continued in this limited open pit, it will be necessary to install hoisting works to care for the ore mined by steam shovels.

Excepting the steam shovel pit mentioned in the preceding paragraph only a very limited tonnage of ore is mined from the numerous terraces lying above that area, and it is reasonable to believe that, if the area stripped as hereinbefore mentioned is available for mining operations, the company would derive the greater tonnage from other sections where the expense of operation would be lower, and also, that underground mining operations would be discontinued.

REMOVAL OF "WASTE" CANNOT STOP.

However, in the matter of stripping the orebody it is pertinent to observe that regardless of the methods employed in future operations it always will be necessary to remove a tonnage of barren material from the mountainside, even after the surface of the orebody has been stripped of overburden. This results from two principal causes; the first that, due to the comparatively limited width of the orebody to the width of the mountain face current operations of ore removal will be attended by the removal of JUST TWICE AS MUCH BARREN MATERIAL; further, that in lieu of decreased cost of operations per ton handled, there will be a marked increase. While it is claimed by the management that when stripping of the orebody is completed there will be no necessary for shovel operations only in the absolute mining of ore, such statements are misleading, for the reason that, so long as the company continues surface mining with shovels the expenses of stripping operations always will bear a ratio approximating twice the cost of steam shovel mining of ore. Therefore, by reference to the last paragraph of this paper it will be noted that, if charges are made as they should be, a profit, legitimately earned, will not appear.

To briefly outline why it will be necessary to continue stripping operations after the orebody has been stripped across two dimensions, if steam shoveling methods are to continue, the following will serve:

First assume the general average dimensions of an orebody 400 feet in width by 3,000 feet in length, by 400 feet in depth cutting obliquely across a central elongated mass of barren material, approximately three miles in circumference at the base and attaining an average elevation of 1,000 feet above the surrounding country. Assume the general average mountain slope to range between thirty and forty degrees. Now consider that the average thickness of barren material capping the orebody is 100 feet. Beginning at the base and continuing to the top of the mountain a number of terraces affording a grade consistent with the length of swith-back used are constructed. Stripping of the overburden is begun and the orebody uncovered across two dimensions, during which op-

eration it has been necessary to remove just twice as much (at the lowest calculation) barren material from the areas immediately adjoining the orebody as were contained in the original capping of the orebody. Continue operations along the third dimension (depth) and then determine if it will be possible to eliminate a continuance of stripping of material from both sides of the orebody, without occasioning impossible bench slopes and correspondingly heavy railroad grades. Also, consider that as reduction of the mountain is accomplished the length of lead (haul) correspondingly increases. From this illustration anyone can gain a favorable idea of the situation at Bingham, and the impossibility of dispensing with stripping operations. It makes no difference whether operations are conducted along the longitudinal axis of the orebody or its transverse section, the result will be the same. It is quite apparent, therefore, that the extracting of the limited orebody by steam shovel methods is tantamount to moving a great portion of the mountain, and from the point of view of economic mining, is absurd.

In view of the present conditions of the mountain upon which steam shovel mining has been performed it would present a difficult engineering problem to determine a system of caving the underground orebody without serious losses of ore in the upper area which have partially been stripped. Steam shovel mining, therefore, will have to be continued for a while at least.

A very desirable means of mining the orebody (which I understand is under advisement by the Utah Copper management) is the acquisition of the Mascotte tunnel which serves the Ohio Copper Company. Either this tunnel, or one similar to it would solve the problem of mining, and afford a cost per ton of ore mined of about thirty cents. The orebody then could be mined either by a modified caving system, or a series of mill holes, and would be productive of a saving of several millions of dollars annually.

MILLING OPERATIONS.

The Magna and Arthur plants of the Utah Copper Company are at Garfield about eighteen miles northward from the Bingham mines. The ore is hauled thereto via the Rio Grande Western railway and the Bingham & Garfield railway, the latter owned by the Utah company.

The combined normal capacity of the Magna and Arthur concentrators is 21,000 tons daily, and in flow-sheet they are of the same type as the Ray Con. concentrator at Hayden, Arizona.

As stated by the management in the report hereinbefore referred to the total tonnage of ore treated at both plants during the year 1911, was 4,680,801 tons. The average content of the ore was 1.51 per cent copper, from which there was a stated recovery of 21.03 pounds per ton—equivalent to an extraction of 69.53 per cent. There is some doubt about the correctness of the above stated figures, inasmuch as the management in the conduct of its business always "juggles" the reports to meet a favorable tonnage treatment, percentage extraction, and so forth, so that internal operations can be covered up.

Not at any of the plants operated under the same management are conditions maintained on a normal unit basis. There is always an apparent tendency to sacrifice efficiency by putting through a maximum tonnage, regardless of the copper content of the ore, and circumstances at the Utah Copper mines demand that maximum tonnage be treated if any copper is at all to be recovered by the concentrators. Consequently, it is safe to assume that the general average copper content of the ores put through the mills during 1911, did not exceed 31.02 pounds of copper per ton, and that the mills averaged throughout an overload of at least twenty-three per cent. Under the circumstances the average percentage copper recovery did not exceed 52.56 per cent. Of course the public receives figures on the operation of the concentrators, but such information as might be given them is of no value, only insofar as it serves to occlude the shortcomings of the management.

An instance of this practice is presented in the following: On the record sheet kept in the offices of the company I have in mind the daily operations of the mills are entered in ink. This report outlines the tonnage of ore treated; average content of mine-run ore; average tailing; ratio of concentration; copper content of concentrate produced; cost of operation, and such additional data as required in that line of operating. However, incidentally, and on the same report there is kept a series of figures in pencil as a means of comparison. One set of figures represents what is termed the ACTUAL operations, the other what is termed the APPARENT operations. The statement of ACTUAL operations represents, as the term implies, the actual results obtained, and the statement of APPARENT operations represents what they "ought to be." The stockholders and public are given the latter set of figures for perusal.

The Utah management states that the average cost of milling ore during 1911 was 41.68 cents per ton, but this figure is based upon the treatment of an increased tonnage of 4,680,801 tons as hereinbefore outlined, and therefore is not representative of the actual cost, which is several cents higher. This results from the fact that when the efficiency of a mill is sacrificed to tonnage treatment it does not make any difference how much material is run through in excess of its normal rated capacity, the cost of operating does not increase above a definite limit—which is its maximum after it has been "tuned up."

PRODUCTION COST OF COPPER.

The most important feature in connection with the operations of any mining or metallurgical enterprise is the comparative cost of production. Therefore, in the following paragraphs attention will be given to the production cost of copper by the Utah Copper Company. The quantities and amounts used in the estimates herewith given are those contained in the company's annual report for 1911, and while numerous corrections could be made with reference to tonnage mined, and so forth, it is best, perhaps, to use the management's figures, as readers then can make the necessary corrections to meet conditions as they have been pointed out.

The production cost of copper for the year 1911 was 7.8655 cents after applying credit of 1.07 cents for gold and silver recovered. A net recovery of 93,514,419 pounds of copper is reported.

By referring to previous paragraphs it will be found that the absolute expense of production costs (wherein no allowance is made for any deferred charges whatsoever) results as follows:

Mining expense 4,680,801 ton at 31.98c	$ 1,497,020.16
Stripping ore, 11,337,256 tons at 33.73c	3,824,056.45
Freight on ore	1,440,748.55
Milling cost	1,950,988.83
Smelting, refining and freight	2,717,592.85
Selling commission	118,261.64
Improvements, equipment mines and mills	1,215,120.76
Total	$12,763,789.24
Copper sold, 93,514,419 lbs. at 12.6463c.	$11,826,164.58
Gold sold, 40,202,916 ozs. at $20.00	804,058.32
Silver sold, 366,906.960 ozs. at 53.3c	195,564.36
Miscellaneous	165.56
Total	$12,825,952.82

From the above it will be noted that the net operating profit, (which should include also an item of $30,966.00 for interest paid) is $62,163.58 for the year,

with which amount dividends amounting to $4,703,858.42 were paid during the year, occasioning a deficit of $4,640,858.42. If, in addition to the interest charges of $30,966 mentioned above, we should add a difference of $35,594.65 which appears as the excess charged to mining according to the company's report (the amount given being in the annual report as $1,529,275.62 in place of the above stated amount—the correct amount, however, should have been $1,493,680.97, or at the rate of 31.91 cents per ton in place of 31.98) the aggregate would have been more than enough to have completely cleared the profit of $62,163.58 as above stated, and occasioned a direct deficit of $4,497.07 for the year. This, then, exclusive of income from other investments (such as Neveda Con., and so forth) is representative of operations at the Utah Copper Company's properties. The production cost of copper, therefore, is 13.65 cents per pound, and, after deducting 1.07 cents for gold and silver credits, the cost appears as net 12.58 cents per pound.

Since the commencement of steam shovel operations at Bingham it has been necessary for the Utah company to carry a tremendous floating debt to care for the stripping expense, and while the item appears in reports to stockholders as a deferred charge for which a sinking fund has been established to cover, at the same time it is noticeable in recent reports that the tendency is to charge the item to capital account through the medium of the profit and loss statement, wherein it is not so conspicuous and can readily be cleared from the books at any time through the method of accounting employed by the company.

In the preceding paragraph the direct charges of stripping operations are included in the production cost of the copper as it should be, with the exceptions hereinbefore noted, and then there were many miscellaneous items eliminated in consideration of the acceptance of the more important charges, which, had they been used, would have tended to increase the production cost a few points. The production cost of copper for 1911 is representative of about the average cost during the past few years, and it is plainly evident that, only by charging off stripping expense, cost of improvements and other such important current expenses that the company has, together with its income from the Nevada Consolidated Copper Company and similar investments, has it been able to create a dividend. It is quite evident that a dividend has not been earned, but created and the natural suggestion is that operations are being conducted entirely upon borrowed capital.

The mining property of the company is valuable, but not in the same degree as the management states. Like other great properties its contained orebodies are limited in extent and value, and intensive development with the changes necessary in mining methods doubtless would permit its operation to a substantial profit—provided it were not encumbered by the heavy indebtedness which apparently exists, from what has been said above, and free from the management of stock market mainipulators. Only when the necessary changes are made with reference to mining, milling and operating methods, will the property become a "self-contained manufacturing proposition"—which at present it is not.

EXTRACTING GOLD FROM GRAVEL DEPOSITS (IV)

By AL H. MARTIN.

The mining of gravel deposits overlain with barren overburden present difficulties that appear the more complex the more familiar the engineer becomes with conditions. It not infrequently happens that the surrounding country is on the same level as the overburden, and the varying gold values and particular character of the bedrock renders impracticable the employment of dredgers, elevators or other comparatively favorable methods. It is necessary to either employ cars or wagons to transport the overburden from the deposit (generally economically impossible because of the excessive costs) or stack the debris in banks on either side of the channel and still keep the pay gravel clear and easily accessible. Ordinarily the overburden, or spoil, consists of sand, clay, gravel and boulders ranging in depth from ten to fifteen feet. The problem is not so much the disposition of the spoil, as the clearing of the pay gravel and its constant freedom from the overlying barren ground. The steam shovel, drag-line excavator and other methods suggest themselves, but each has its particular field, with its adoption based upon the natural conditions of the deposit and the work to be done.

GRAVEL-DIGGING DEVICES.

The steam shovel easily commands stellar attention as a particularly efficient digging machine, but is handicapped by its short excavating radius, and even more limited stacking facility. For shallow work the steam shovel has proven markedly effective, but when deeper stripping is carried on the inability of the shovels to stack their burdens advantageously becomes apparent. Unless the sides of the cut are fairly steep, the shovels are unable to stack the debris firmly, sloping sides resulting in unsatisfactory work and frequent delays. With shallow deposits, however, the steam shovel has been proven an efficient means for divesting the pay-gravel of its barren capping.

The machine generally employed is provided with 65-foot booms and dippers of 3½ feet capacity, with a digging and stacking capacity of 120 to 200 cubic yards per hour. The lower frame is fashioned of steel, mounted on four swivel trucks with four double-flange wheels to a truck. For rotation of the machine a rail circle and steel circular rack are installed at the upper portion of the frame. A hydraulic equalizing device is provided to secure a uniform weight adjustment, permitting the shovel to be moved ahead and operated on uneven tracks without twisting the frame or subjecting it to unnecessary strain. The device also keeps the turntable on a constant level, facilitating its revolutions with a minimum usage of power and lessened strain. Each machine is self-propelling, with the dippers capable of excavating excessively hard ground.

However, refractory material naturally results in less capacity per hour, and it has been found well in such cases to have two or three men in advance of the machines to drill and blast the refractory material. The short-boom shovel has many advantages over the long-boom type and is favored by many engineers for stripping where the capping is not too deep. But no matter what type of machine is used, the steam-shovel operator is constantly hedged about with limitations. When the ground is soft, with decided slopes, even a long-boom machine is unable to stack the spoil to advantage, and the constantly sliding ground makes wide cutting exceptionally difficult.

To reinforce the steam-shovel, several appliances have been devised, including the locomotive crane and portable incline-tipple. The locomotive crane travels on rails along the beam as the shovel makes its cut and elevates and stacks the debris as it is excavated. Three to

five loads of a dipper are deposited in a receiving box, which is raised by the crane and the contents deposited on the bank. While the crane is elevating and discharging one box, the shovel is loading another. Fairly good time is thus achieved, but some strong objections to this method have been aroused by the breaking of boxes, additional labor required, and difficulty experienced in effecting rapid detachment from the empty box and connection with the loaded receptacle. The incline-tipple has proven its ability to handle the material excavated by the shovel and has many advocates, although the construction cost is so high that only under favorable circumstances is its employment considered justified. The machine operates just back of the shovel, and the cars are hoisted by a double-winding engine with each drum operating independently. This permits practically continuous action.

While the steam-shovel has proven highly efficient for the mining of ore previously broken by blasting, it is not generally favored by engineers for placer mining save in unusual cases. It is being employed to some extent, but the drawbacks affecting its usage, as herein indicated, militates against popular approval. The machine lacks that mobility essential in placer mining, and the necessity of using auxiliary, and usually expensive, means for handling the material excavated, renders its employment impracticable in the great majority of instances.

THE DRAG-LINE EXCAVATOR.

The drag-line excavator is a machine that has elicited much favorable comment from operators in Siberia, America and other countries, where the mining of gravel deposits under unfavorable conditions has received particular attention. The type of machine largely favored is of the rail-circle, with the lower frame mounted on trucks, and sixty to 100-foot booms. The excavator operates on a rail track and digs to a depth of a few inches to thirty feet, and commands a radius of 100 feet from the center of the tracks. The hoisting cable runs over a sheave at the outer end of the steel boom and connects with the buckets, usually 1½ to 2 cubic yards capacity. This cable is actuated by the first drum of a double-winding engine. Over the second drum stretches the pulling cable, attached to the chain-bale of the bucket and a short compensating line fastened to the forehood of the bucket. This enables the bucket to be suspended in any position and naturally increases the mobility of the device. The bucket is usually provided with manganese steel teeth and bites into the most difficult capping or gravel with easy facility. The bucket is dropped to the fresh ground or into a cut and dragged toward the machine by the pulling cable, filling as it drags. When full it is hoisted and swung by the swinging engine, through ropes or geared swing, over the desired point on the bank where it is discharged by loosening the strain on the drag line. By this means the overburden is easily stacked to a height of twenty feet at any point within the radius commanded by the machine.

The machine works backwards and with the working out of one section of a cut, the track couplings are removed by two track-layers, the machine raises a section of the track from in front and replaces it in its rear, and the new line is connected. The operator again lowers the bucket to the cut and operations are resumed. While the bucket can only be successfully discharged from a position vertically below the head sheave, it is capable of excavating to a distance of fifteen to twenty feet to each side from the vertical and to a length of twenty feet in front of the excavator. The drag-line excavator possesses manifold advantages over other mechanical digging devices, and its mobility makes it particularly efficient under most conditions. At the Kolclan mines, East Siberia, machines of this type are excavating gravel to a depth of twenty-seven feet and handling sixty cubic yards per hour. Under favorable conditions the working costs average around nine cents per cubic yard.

SIBERIAN PRACTICE.

In Siberian practice machines with long booms, approximately 100 feet, are preferred for stripping, while sixty-foot boom excavators are deemed desirable for actual gravel mining. The gravel thus excavated is discharged into Russian floating washing plants equipped with log washers, screens, gold-saving tables and tailing stackers, or diverted into ordinary sluices. As an excavator the drag-line bucket is hardly as efficient as a steam-shovel, but as a combination digger and stacker it has won commanding recognition as an efficient and economical machine. Two types of buckets are used, those having swinging chains or fixed bales. The bucket with the stationary bale is a splendid excavator of hard ground, and is more readily controlled and guided than the chain type, but the latter have proven their merit in digging soft or previously loosened material. The initial cost of an excavator is not as large as that of a steam shovel, while the greater facility with which it may be operated and transported are salient points in its favor.

The great advantage of the drag-line excavator over the steam-shovel is its ability to stack the material under conditions that require auxiliary equipment when the steam shovel method is employed, and this is a factor that means the employment of the drag-line machine in practically all placer mining enterprises where mechanical excavators are required. Two men, an engineer and a firemen, are required to operate the drag-line excavator, with three laborers employed to attend to the tracks. Thus the labor cost is low. In operating the larger type of the steam-shovel, two to three men are required on the machines, and four to attend to the tracks and assist in moving the shovel ahead. After years of experience with excavators and steam shovels operators have generally pronounced the former the most economically operated, save in cases where the shovel has been able to stack its own spoil. There are circumstances when the excavator can hardly be employed to advantage, as in the case of ground too difficult to dig, but the device is commanding increasing attention from operators in all sections of the world.

An excavator that has attracted interest in Germany and Russia for extraction of gravel at low costs is based on the dredging principle. The digging machinery consists of a bucket-line and dredge buckets. Instead of being discharged into hoppers, however, the gravel is hoisted over a tipple and dumped onto a belt-conveyor delivering to the tailings bank. The material is dug dry, and the machine has proven a success in many ways, but it is questionable whether such an installation would prove satisfactory in the mining of the coarse gravel generally encountered in most placer regions.

Besides the machines herein described for the winning of gold-bearing gravels from refractory deposits, numerous other contrivances have been evolved by ingenious inventors, but the devices have found little popularity with the matter-of-fact engineer. It is only when the dredging, hydraulic, elevator or other favored methods of mining gravel is proscribed by unsatisfactory conditions that the engineer turns to the mechanical excavator, and in this field the drag-line excavator has met with greatest favor, save in the isolated instances where the employment of the steam shovel has naturally met the requirements.

NOVAL COMBINATION SCHEMES.

A machine constructed along somewhat novel lines, but giving excellent satisfaction under rigorous exactments, is being operated in the Ruisseau des Meules district, in the province of Quebec, Canada. It consists of a steel elevator operating on rails, with the excavating equipment the digging section of an elevator dredge. The buckets are close-connected, with a capacity of 3½ cubic feet each and excavate to a depth of thirty-five feet. The elevator is mounted

on four trucks, each truck provided with two wheels, and the buckets discharge into a riffled steel sluice. Two hydraulic giants wash the gravel down to the elevator pit from whence the dredge buckets gather the material and delivers to the sluices. The wheeled trucks operating on rails spaced twenty feet apart enables the position of the machine to be changed whenever necessity demands, and the length of the steel sluice is augmented by sections of wooden flume from time to time. The waste material is sluiced away as in ordinary hydraulic mining. The process is a combination of the elevator, hydraulic and dredging methods and has proven markedly effective in handling a deposit that presented considerable difficulty because of unfavorable topographical conditions. Limited water supply, together with the slight grade of bedrock compelled the employment of the elevator method, and the application of the dredging principle for the excavation of the gravel washed into the elevator pit by the giants proved exceptionally satisfactory. The plant has a capacity of 180 cubic yards per hour. Electricity is used for power.

A combination hydraulic-dredger-mechanical-stacker method of handling gravel has been installed by the Tarr Mining Co. at its placers near Smartsville, California. The mines were formerly worked by the hydraulic method but were forced to close by the Anti-Debris Association, because of tailings deposited in navigable streams. In designing the plant it was imperative that it be constructed to operate within the stringent regulations affecting placer mining in California, and its building embodies several engineering features of particular interest. The gravel is hydraulicked by monitors to a sump located directly in front of the dredge building. This is a stationary structure, solidly constructed of concrete and sheet iron, with the excavating apparatus a steel dredge digging ladder of the regular girder type. The ladder carries fifty-two seven-cubic foot buckets. The latter excavate the gravel washed down by the monitors as in ordinary dredge mining and elevates to a trommel having dimensions of six by forty-five feet, with the screen containing half-inch holes.

From this the undersize passes direct to the gold-saving tables, provided with Hungarian riffles and having an approximate gold-collecting area of 4000 square feet. The fine materials passing from the tables flow into a bedrock tunnel about 2600 feet long which delivers to the concentrating plant. This is equipped with Overstrom tables, and was designed to save the black sands in addition to any gold and platinum that may have escaped the gold-saving tables. Before the product is fed to the concentrators it passes through revolving screens which permit only the fine materials to be concentrated while the coarser feed is diverted to the settling ponds.

The oversize from the trommel commands a belt-conveyor system, about 570 feet long and constructed in two sections. This delivers the tailings to two Bleichert tramways, which distribute to best advantage over the extensive dumping ground. The coarse material passing the gold-saving tables, and prevented by the revolving screens from joining the feed to the Overstrom machines, flows to the settling pond composed of a concrete dam. By this method the escape of even minute quantities of foreign matter to navigable watercourses is effectively prevented. The digging ladder is actuated by a 100 horse-power electric motor, while each of the two sections of the conveyor receive power from 50-horse-power machines. A 30-horse-power motor drives the revolving screens.

The plant has not been sufficiently operated to demonstrate its real merit, owing to friction among the stockholders which has constantly impeded activities practically ever since the completion of the works, but the short runs made indicate the methods can be profitably applied. In designing this plant the engineers were confronted with conditions demanding originality and recourse. Dredging was impracticable, because of the structure of the deposit and other unfavorable natural circumstances, while hydraulicking was proscribed by the laws of the State. Mechanical excavators were given consideration, but the method eventually determined on appears to have many recommendations in this particular application.

AVOID FAILURE BY STUDY.

When the question of installing equipment on a placer property is attentively examined, it is apparent that every engineer must be influenced by the particular condition he is called upon to control. A device that would be eminently adaptable to some districts would only spell failure if applied under diametrical conditions. The best type of excavator for any special work depends largely on its ability to handle the maximum amount of material at lowest economical costs, together with its facility for removing and stacking the spoil. The first cost of an installation is not always the paramount consideration—its adaptability for the particular work outlined is the prime factor. Frequently a combination of methods means success where it would be practically impossible to achieve best results with any one machine. Examples of successful installations of both types are sufficiently numerous to guide the engineer to the selection of the best method for his specific purpose.

But, not only is the type of machine and general structure of the deposit to be considered. In every important mining district the lack of even rudimentary knowledge of his subject by a so-called mining expert is silently but eloquently testified to by the rusting plants that could never have been anything but failures. Thus, in the upper valley of the Grand river, Colorado, a number of costly installations have been humiliating failures largely because the builders learned not how to prospect their holdings before installing equipment, and also because persistent attempts were made to recover the gold by amalgamation, when even cursory examinations would have shown that much of the gold was coated and would not amalgamate. And yet, despite consistent failures, subsequent installations continued to be made along the same old lines. Early mistakes in a new district are to be pardoned, but when the errors are continued and wholly because of the ignorance or carelessness of the psuedo-engineer, the strongest condemnation is deserved. In still other fields companies have experienced ignominious defeats because no provision was made for an adequate water supply, or because the type of installation was manifestly unsuited for the work it was intended to accomplish.

There is an immense difference in handling coarse and fine gold, yet many an oldtime coarse-gold miner attempts to recover the fine values by the same methods that prove so efficacious in the recovery of the coarser product. And when he fails to obtain the anticipated results the usual procedure is to damn the whole district, whereas the application of rational means would have frequently made the proposition a profitable one. Fine gold readily escapes the mediums provided for the recovery of the coarse product, and it is only by realizing this and using machines adapted for the particular treatment of the fines, that the engineer can hope to gain success when confronted by such instances. And unless he possesses the requisite knowledge of the district, character of the gold and nature of the deposit, no engineer can safely decide upon the character of the installation best fitted for the accomplishment of the work in hand.

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It simply gives a fellow the "shivers" to think of the anguish that will be experienced by the holders of Utah Copper, Ray, Chino and Butte & Superior if the public holds aloof much longer.

CHINO COMING HOME TO ROOST

We find the following in the Boston News Bureau of the 17th under the caption, "Paris Selling Chino—Garbling the Facts:"

> Paris has been selling Chino Copper Company shares, of which a large block was placed in that city over a year ago. This selling may be attributed to absolute ignorance in that city of true conditions regarding the company's affairs.
>
> A Paris cable to the New York Times weekly financial publication—The Annalist—last Monday read as follows:
>
> "The porphyry copper mine shares have been more affected and are weak, but rumors that the Chino Copper Company will discontinue its dividends are discredited; however, a reduction of the rate is expected."
>
> The Annalist cable editor was apparently no better informed than his Paris correspondent, for in his resume of the entire foreign correspondence service for the week then ended, he called attention to the same alleged condition.
>
> Chino directors have yet to place their shares in the dividend ranks. With the maintenance of 17¾-cent copper, a $4 dividend basis would doubtless have been assured. What action the board will take when it meets late this month is problematical.

Pursuing the logic of the foregoing, which is peculiar to the string of subsidized mining and market reporters on "Managing Editor" Jackling's staff, had the price of copper metal advanced to 35½c. a pound, the dividends upon Chino stock could easily, no doubt, be maintained at double the rate mentioned or $8 per share. And if the whole of the mining costs were charged to the deferred, so-called stripping account, instead of only four-fifths of such costs, as at present, the dividend rate could easily have been advanced several points higher and the cost per pound of producing copper made to appear much below its present premier low-cost rate.

On the other hand, if the price of metal should fall back to 12c. a pound and if the management of the Chino Copper Company should charge to production all of its operating costs—as is customary with other people in such cases, and should report the large volume of high-grade ore which now goes direct to the smelter and is counted in to swell the volume and value of concentrates—the loss on the mining and treatment of ores passed through the concentrator would greatly exceed the losses suffered by the Utah Copper Company, as shown by its last quarterly report, which was nearly 3c. a pound.

Evidently our French brothers have discovered some of the tricks of this precious bunch of fakers.

Evidemment nos freres francais ont decouvert quelquesunes des ruses de cette prescieuse foule de faquirs. Vive le "horse-sense" francais; a bas Lawsonian humbugs!

Will someone please tell us why it is called the Butte and Superior COPPER Company?

MORE "SMOKE" COMMENT

What has become of the Herald-Republican's "campaign" for an abatement of the "smoke nuisance?" And why has the fire chief subsided? He was quoted in December as promising a quick clean-up "as soon as we get a new police judge, on the first of the year." The City Commission and the Commercial Club—and the members of the Legislature—all ought to be hustling for an abatement of the nuisance. What is the matter?

Did not Mr. Alter, in the last issue of Mines and Methods and two of the daily papers, present unimpeachable evidence respecting the REAL cause of all the trouble? And, did he not clearly define a remedy that would be adequate and permanent?

On December 15th last the Salt Lake Herald-Republican loudly proclaimed: "Every citizen of Salt Lake is disgusted with present conditions and the Commission will find a healthy public sentiment behind whatever it may do to enforce the law and accomplish reform."

Now, if the City Commission, or the Commercial Club, or the fire chief, or any civic organization finds, as a result of the facts involved in the problem—as made plain by this magazine—that state legislation is necessary to wipe out the evil and clean up this town, why is not the aid of the Legislature, now in session, sought?

If it is felt that the showing and evidence presented by Mines and Methods in the last two issues is lacking in point or emphasis, let us suggest an unbiased perusal of the additional evidence presented by Mr. Alter, who is one of the Government's meterological experts here, in this issue.

Mines and Methods has been and still is spending money and doing its full share to show the people here what the real trouble is and point the only way to relief. Upon the showing made is there any reason why our county, city and state officials should delay in providing a means of applying the remedy?

> The Hardinge Conical Mill Co. of New York has received, among other orders, orders for two 8-foot Hardinge Patent Conical Pebble Mills from the Butte & Superior Copper Co. of Montana, and for three mills of the same size from the Commonwealth Mining and Milling Co. of Arizona.—Trade Note in Mining Science.

From which the deduction is drawn that these "great engineers" of the Utah Copper combine are really beginning to tire of making apologies for their Janneyized Chilian mills and are seeking something practical—something that will at least partially arrest "the overflow of mineral" in the tailings.

A common custom in Mexico and the Latin Americas is that of placing placards at mine entrances bearing the supplication: "Dios nos Guie"—translated, "God Guide Us." A sign like that placed at the entrance to the Utah Copper mines would be most applicable if the word "Guide" was changed to "Help."

Isaac Guggenheim of New York, who is in Pasadena, says: "Opening of Panama canal will do much for this coast. It will do wonders for South America. I will invest in Chile. The assaults on capital which have been common since the day Theodore Roosevelt stepped into office make capital timid. Moneyed men will not invest within our jurisdiction, but will seek investment elsewhere." Isaac seems to be quite peeved.

"Vice-president and Managing Editor Jackling of the Alaska Gold Mines Company" has been kept quite busy during the past several weeks repairing holes that have been shot into the barricades protecting the operating methods at Utah Copper, Ray and Chino. But, judging from the conflicting statements of various members of his publicity staff with those of his own, the "recoverable values" in the declarations made and excuses offered will prove negligible—they will escape with the "overflow of copper in the tailings," for Mr. Jackling has said: "We only give the stockholders such information as they are able to understand and digest."

Several weeks ago, while gathering data for articles on the Ray Consolidated, Chino and Miami properties for Mines and Methods, James O. Clifford, the well known mining and metallurgical engineer of El Paso, stumbled on to the Utah Copper Company's annual report for the year 1911. Toying with the figures and statements it contained disclosures were unfolded that prompted him to come to Utah and make some observations for himself. He was profoundly impressed with what he saw and heard during his trips to Bingham and, while he found it impossible to cover the subject in such detail as he would have preferred to do before leaving again, he turned in an article—appearing elsewhere in this issue—which, while couched in modest, impartial terms, displays so much of the REAL condition of affairs affecting the company's methods, that readers will gather valuable information through a careful reading of it. His analysis of the company's 1911 report will be found of value in arriving at a fair estimate of the statements which the company will prepare and present in its forthcoming report for 1912.

THE SULPHURIC ACID INDUSTRY

By UTLEY WEDGE.*

To arrive at a broad understanding of the sulphuric acid industry in the United States, it is necessary to consider it in its relation to the great industries which require the production of sulphuric acid.

The greatest of these lines of manufacture which require sulphuric acid, are as follows, and opposite each is noted an approximation of the quantity of sulphuric acid consumed in that industry. Figures given are in terms of tons of 50 deg. Be sulphuric acide per annum:

	Tons
Manufacture of fertilizer	2,400,000
Refining in petroleum products	300,000
Used in iron and steel and coke industry	200,000
Manufacture of nitroclleulose, nitro-glycerine, celluloid, etc.	150,000
Manufacture of aluminum sulphate and the different alums, sulphates of magnesium and similar salts, carbon dioxide and hydrogen, sulphide gas, aniline and other organic dyes and colors, hydrochloric, nitric, hydrofluoric, chromic boracic, acetic, picric and other acids, either, glucose, blue vitrol, zinc sulphates, and in the metallurgy of copper, gold and silver and general chemical practice	200,000
Total	3,250,000

In the manufacture of phosphatic fertilizer, phosphate rock is treated with sulphuric acid to render the phosphoric acid soluble. One ton of rock phosphate requires treatment with about one ton of 50 deg. Be sulphuric acid.

In refining petroleum products, sulphuric acid 66 deg. Be and sometimes fuming acid is used for the removel of tarry matter and to some extent sulphur compounds. For example, one thousand barrels of illuminating oil requires for its refining about two tons of oil of vitriol.

In the iron and steel industry, very dilute sulphuric acid, free from arsenic, is used for cleansing steel plates or wire preliminary to galvenizing, making copperas as a by-product; also the steel companies have gone extensively into the production of coke with by-product coke ovens, one of the products of which is sulphate of ammonia, which requires a little over a long ton of 50 deg. Be sulphuric acid for each net ton of sulphate of ammonia produced.

In the manufacture of nitrocellulose, nitro-glycerine, etc., highly concentrated or contact sulphuric acid is used in connection with strong nitric acid to absorb water formed during nitration which would otherwise interfere with the chemical action desired.

In the manufacture of alum, either bauxite or white alumina, are treated with 50 deg. Be sulphuric acid, free from arsenic, to form aluminum sulphate.

In the manufacture of sulphate of ammonia, ammonia gas is absorbed in scrubbing towers by dilute sulphuric acid or solutions of ammonia are treated direct with sulphuric acid.

In the manufacture of blue vitriol, metallic copper is dissolved by hot sulphuric acid, very dilute. Dilute sulphuric acid is also used to some extent in leaching copper ores, concentrates or slimes for the recovery of copper values.

No attempt is made to give a complete category of the uses of sulphuric acid, but enough has been specified to show the distribution of lines of manufacture which require sulphuric acid.

Phosphate rock deposists are in Florida, Tennessee, and South Carolina. There are also deposits of phosphate rock in Utah and elsewhere in the western states, which will have great industrial importance as soon as the demand for phosphatic fertilizer in the west has grown to a point to justify the erection of fertilizer plants.

The location of fertilizer plants is decided by the following facts:

The phosphate rock has, in any event, either acidulated or not acidulated, to be transported rom phosphate deposit to agricultural district where it will be consumed. The complete fertilizers can be manufactured near the point where the fertilizer will be used. Therefore, a determining factor in the location of phosphatic fertilizer works is the freight on sulphuric acid or crude material from which it is manufactured.

One ton of pyrites containing 50 per cent suphur will produce 2.35 tons of 50 deg. Be sulphuric acid, so that it is cheaper to transport iron pyrites than to transport the quantity of 50 deg. Be sulphuric acid which a given amount of iron pyrites would produce.

Sulphuric acid plants in connection with fertilizer plants are therefore generally located adjacent to the agricultural district where the fertilizer will be consumed and not near the deposit of phosphate rock, and combined sulphuric acid and fertilizer plants located near phosphate rock deposits are there merely to supply agricultural requirements in that vicinity. Combined sulphuric acid and fertilizer works are therefore located in parts of the United States where phosphatic fertilizer is required.

Fertilizer is extensively used in connection with the growing of cotton, and the southern states, denoted as cotton growing states, contain very numerous sulphuric acid plants.

In the northern and eastern states, the use of phophatic fertilizer is not so extensive and a less number of combined sulphuric acid and fertilizer plants supply the demand.

The consumption of fertilizer, other than in the western states, is growing so enormously that a most unusual business situation is developing, and even in Utah combined sulphuric acid and fertilizer plants are now contemplated.

Much the greater portion of sulphuric acid produced in the United States is made from iron pyrites.

During 1911, pyrites was supplied from the following countries:

	Net tons
Spain	815,000
Portugal	133,000
United States, Canada, about	350,000
Total	1,208,000

Of this amount 584,000 net tons were delivered to plants in the south manufacturing sulphuric acid exclusively for the production of fertilizer, and 236,000 net tons were delivered to plants in the north manufacturing sulphuric acid exclusively for the production of fertilizer.

These quantities of pyrites would represent a production of sulphuric acid in the fertilizer plants in the southern states of about 1,300,000 tons of 50 deg. Be sulphuric acid, to which should be added 275,000 tons of 50 deg. Be sulphuric acid produced as a by-product by the copper smelters in Tennessee, practically all of which is consumed in the manufacture of fertilizer in the southern states.

The 236,000 tons of pyrites delivered to plants in the northern states, manufacturing sulphuric acid exclusively for the production of fertilizer, would represent 529,000 tons of 50 deg. Be sulphuric acid.

In addition to the above fertilizer-acid, considerable quantities of sulphuric acid are manufactured in works doing a general chemical business and shipped to

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ignored. Many of these replies showed the properties to be mere prospects with the only information that supplied by the discoverer. In some instances, definite information as to the values were even lacking, the one thing which should in this case have been most prominently stated. Taking them all in all, they showed a lack of preparation for sale; too many of them, the old spirit of getting something for nothing.

This is a very strong example of what has been shown in other cases and shows the evident need of training the mining public to the needs of the case. Not a training to sell their own mines, but one in showing the needs of the man who will try and do it for them. Vast sums of money and tons of advertising paper are used to market an article which sells for 5 cents per unit. The same kind of action would not be needed to sell a mine, but it is along the same lines. Time enough to justify expenditure for advertising in some form and take care of the known fact that it is almost impossible to hurry the matter from any side. Time for examination and sometimes for a second one, consultation, organization, all must be considered and allowed for. Too often the failure of an irresponsible salesman condemns all of them when a very little effort would have shown the mistake before its making. Very little can be hoped from 30 or 60-day options under the usual conditions, as it gives no chance to cover the field in any manner and does not warrant advancing the money necessary to bring the property to the attention of the people who might be interested. In this country, with the business always on a contingent basis, this is a consideration. Capital is very shy and must be hunted out, while mining is only one of hundreds of forms of investment always hunting. Mining as a general form has very little standing, and its attractiveness must be shown for the individual property. It is just as necessary to tell the story properly as to have something worth telling about, keeping in mind, however, that plain facts sound best and that anything you say will be used against you if possible. Generally speaking, recommendations for equipment are of little value and confuse the main idea, unless accompanied by good reasoning and evident knowledge of the requirements. The real thing is to have something which has the conditions and which you can show has them, and which you have in shape so they will show themselves. To have a property turned down only adds to the difficulties and should not be risked by premature offering.

WHAT IS COAL LAND

It is so often the unpleasant duty of the United States Geological Survey to refuse to reclassify as noncoal land areas that have been classified as coal land, because the evidence and affidavits submitted for reclassification are inadequate, that a word of explanation on what is considered "adequate" may make clearer the position of the Survey in the matter.

It is a widespread popular impression that if coal is found outcropping on a tract, the land is coal land, and that if no coal is to be found outcropping the land is non-coal land. If this were true probably more than one-half of the coal produced in the country (in some States more than 95 per cent) would be coming from mines not on coal land.

As an illustration, 196 miles in Indiana in 1908 produced 11,997,304 tons of coal. Of these 196 mines, 15 were working the coal from the outcrop and produced 400,733 tons, or a little over 3 per cent of the total. The rest was mined from land, the surface of which showed no coal. In Illinois the percentage is still less, and in both States the average production of the mines working on the outcrop is small, compared with the average of all the mines. The percentage of coal worked from the outcrop is greater in Pennsylvania, West Virginia, and the southern Appalachian States than in the two cited, but not much if any greater in the Michigan field, the western interior field, or some others of the large fields of the country. It is true that in many of the fields when first exploited mines were mostly driven in on the outcrop, but for two reasons that condition has greatly changed. First, the coal close to the outcrop has been mined out; and second, after a time it has been found to be cheaper to mine the coal from shafts sunk to the bed from a point some distance back from the outcrop than to haul the coal, water, and waste up the slope of the bed as it pitches into the ground.

If, therefore, any producing coal field is examined there will usually be found a belt of outcrop in which the coal-bearing rocks rise to the surface of the ground, and outside of that belt an area, which may amount to thousands of square miles, where the coals are all below the surface and the surface rocks may even be of entirely different age and perhaps not coal bearing at all. In Indiana shafts have been sunk to coal beds at a depth of 250 feet without any preliminary drilling where the coal bed did not outcrop nearer than 15 miles, and many of the mines of Illinois are 25 to 50 miles from the nearest outcrop of the coal they are working.

In classifying land as to its coal character a few general principles are involved:

1. If the land is known to be underlain only by groups of rocks known nowhere to contain coal, the land is assumed not to be underlain by coal and to be non-coal land.

2. If land is known to be underlain by one or more groups of rocks known to contain workable beds of coal, and a study of the dips shows that those groups are not too deep for the coals they contain to be worked, the land may be presumed to be coal land.

In nearly all cases where public lands have been withdrawn pending examination and classification it is known or believed that the land is underlain by groups of rocks known elsewhere to contain workable beds of coal. In probably a majority of cases it is also known or later examination demonstrates that coal does not outcrop on most of the land withdrawn but underlies it, perhaps at a considerable depth.

The evidence obtained by the Survey consists of observed outcrops and measured sections, properly located and described on the spot, and analyses made in the Government laboratories from coal samples collected in a definite prescribed way, supplemented when necessary by such second-hand data as appear to be accurate and reliable and to be in accord with the personal observations of the field men.

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A party from the U. S. cruiser Maryland is now inspecting the Matanuska coal fields of Alaska, from which it is purposed to obtain fuel for the navy coaling station at Seward.

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In diamond drilling the core spring sometimes fails to work properly, and the core is left in the hole. It may be picked out, but a better way is to break it up with a chopping bit when it can be washed up.

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A Salt Laker the other day informed a friend that he had 1000 shares of Butte & Superior for which he paid $18 a share and sought advice as to what he ought to do with it. "I must not advise you," replied the friend. "A few yeads ago a friend of mine bought some Newhouse at $8; when it reached $18 he asked me what I thought he ought to do and I advised him to take the splendid profit it then afforded. He did so, but when the stock rose to $26 he upbraided me and bought more. I immediately retired from the advice-giving business and I am still out.

Mines and Methods

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CONTENTS:

"DE CHUTE EN CHUTE"

Following the publication of Utah Copper's fourth quarterly report for 1912 French and English papers have been discussing the company's affairs, and particularly as they related to the claims of increased earning power and promises of greater dividends. The Paris Globe (the Frenchmen's financial Bible) of February 27, after briefly explaining what the Utah Copper situation appeared to be, closed by saying: "Certain English journals are advised that the dividend could be increased. We are unable, however, with any certainty to share that opinion, since the shares have tumbled ('de chute en chute') during the last six months from 350 to 270 (francs)."

In other words the Frenchmen argue—very properly—that neither the company's mining record, nor the action of the stock, marketwise, indicate honesty in the claims made for the proposition.

Commercial Club Tackles The "Smoke" Problem

The people of this city and valley are to be congratulated upon the fact that the board of directors of the Commercial Club have recognized the necessity of determining a means of eradicating the so-called "smoke evil" with which the valley population has to contend. The initial step was taken on the seventh day of the present month, when a discussion of the subject was followed by the adoption of the following preamble and resolutions:

Whereas, the smoke problem in Salt Lake has assumed such serious proportions that it not only is a menace to the health and comfort of our citizens but also threatens the city's commercial prosperity and its attractiveness for tourists, therefore,

Be it Resolved, That the Commercial club is in favor of any reasonable means to abate the smoke nuisance or to mitigate its evil effects. In order that something tangible may be done, be it further

Resolved, That the president appoint a committee of three members of the club, whose duties and powers shall be as follows:

1. To make a careful, thorough, scientific investigation of the origin and cause of the smoke, and to determine whether there is any remedy for the condition.

2. To co-operate with the city, county and state authorities in this task, if such co-operation can be obtained, otherwise to proceed independently with an investigation in behalf of the Commercial club.

3. To employ expert aid for the purpose of ascertaining the chemical and physical properties and effects of the smoke, observing air currents, and studying questions of combustion; and also for the purpose of calculating the financial effect of the present deplorable condition, and of carrying out any proposed remedy.

The committee appointed by the president of the club is composed of gentlemen in whom the utmost confidence can be reposed, gentlemen with experience, ability and energy enough to properly and speedily perform the task assigned to them: Messrs. George H. Dern, O. E. Howard and James H. Moyle. To make the investigation thorough, comprehensive and effective, and to make possible the application of a remedy that will settle the matter once and for all, this committee must have the moral support of the community and the press. There should be no quibbling or attempts at evasion on the part of the "moulders" or "reflectors" of public sentiment. If we are to prove to the world that Salt Lake is what is so insistently claimed—the most inviting spot on the continent on which to establish a permanent residence—every vestige of evidence that would tend to controvert that claim must be destroyed. Surely the newspapers, the city and county officials, the real estate association, the association of women's clubs and every citizen with a claim to civic pride and possessed of a desire to see this splendid city grow and prosper, can labor in harmony for the cause.

For more than three months past Mines and Methods has been doing everything possible to awaken public sentiment and get a movement started that would accomplish the object in view: that of making Salt Lake in reality, as well as name, a beautiful, clean city. There has seemed to be some resentment of the attitude taken by this journal because it has contended that the greatest blame for the smoky, foggy, murky condition of the atmosphere here during the past several months, was chargeable to the smelters operating close to town. However, it must be conceded that we have delved deeply into the subject and that, for every assertion made evidence—unimpeachable evidence, we believe—has been presented to substantiate it. In this issue we present considerable data and matter of an explanatory character that was accumulated by Mr. Alter during his evidence-compiling campaign and we hope that its presentation will be given the consideration it deserves at the hands of those who have now been officially charged with seeking a final solution of the problem and the complete eradication of the nuisance.

During the present month much space has been devoted by the daily press to the work of the Women's Clubs to make Salt Lake a "clean city." We commend every act that has so far been performed and endorse every word that has been uttered. We regret, however, that the inaugurators of the campaign have entirely overlooked the chief cause of this city's uncleanliness and that the papers have seemed loth to bring it to their attention. It is all right to have a general spring clean-up of premises, the removal of unsightly objects, etc.,

and thus present the city's brightest side during the good weather months of the year; but, if we are to impress visitors and the great mass of traveling humanity that enters and passes through the city during the fall and winter months, with the idea that Salt Lake is a charming place, we must so regulate conditions that people can not leave here with stories to the effect that this valley's atmosphere was so charged with sulphur fumes, smoke, soot and fog that it was impossible to breathe without choking, see any distance or appear in clean linen without besmirching the same; we must do everything possible to make the atmosphere in which we live purer and cleaner.

If any of the people of this city believe or have been urged to believe that Mines and Methods has not honestly or properly diognosed the case, we urge them to select some morning when the atmosphere is heavy, between six and nine o'clock, and when there is a gentle breeze blowing from the south, to go out on the bench to the east or north of the city and watch the smoke and fumes from the valley smelters roll into this town. If it is inconvenient to make these excursions, at least go into the north and south streets anywhere from Main street east, and observe what is happening there. Inhale and taste the "fog" that envelops you; note how the damp, heavy soot is being thrown down by this sulphurous "fog" and then decide whether this journal has had cause to place the blame where it has placed it. Go out in the afternoon of such days when a wind from the northwest is sweeping along the west side of the valley and note how the smoke and fumes from the Garfield smelter are carried along the foothills to the south until it is caught up by the currents drifting through the Jordan narrows and is driven back to join the fumes, gases and smoke from the Murray and Midvale smelters in the procession northward again. Don't be persuaded to make these investigations just at a time when heavy winds have swept the landscape and temporarily cleared the atmosphere; go when the trouble is in evidence and learn for yourselves what it really amounts to; go, if you can, at a time when you know that fires are out in town, before the city furnaces and stoves have had a chance to participate. Then, if you find that the "fog," "smoke" and "murk" is there, just the same, accord to us honesty of purpose in making the fight we have made to have something done, and urge the Commercial Club's committee to brave everything in a determination to make Salt Lake, in fact, "a clean city."

And in all earnestness and all good faith we respectfully suggest to the Commercial Club special committee, the Real Estate association and others who are vitally interested in this matter, that if the sentiment is found to be that, while the difficulty can be traced to the smelters, it is against the best business interests of the community to make them move or cease causing the trouble, we get together and work for more smelters. Let us advertise the city as a Pittsburg and make a feature of the amount of "smoke" we can make. Mines and Methods has some large, panoramic views of the city that might be employed to advantage in advertising such a feature and, if that is what is wanted, let us all get together and present our claims for outside recognition on that score. We can supply these pictures. It must be one thing or the other—the two propositions can not be made to work in harmony.

As it stands, we are for a "clean city." Now, let's have the evidence officially presented and then take a standing vote.

"UNTRAMMELED" MINING PRESS

The attention of "Managing Editor Jackling" and his string of sub (and subsidized) editors and prudential reporters (as well as the public) is respectfully called to the "treasonable" utterances contained in the following editorial from the Engineering & Mining Journal of February 22d—last month. We have been taking particular pains to note whether Hayden, Stone & Co., George L. Walker, the Boston News Bureau, the Salt Lake Tribune, Telegram, Herald-Republican, the Salt Lake Mining Review, or any of the rest of the boasted purveyors of "legitimate mining information"—East and West—have had the nerve to reproduce, commend or criticise this article. And the search has been unproductive. The issuance of the company report which has called forth this wholesome and perfectly justifiable comment of the Journal caused a wave of consternation to roll through mining investment channels everywhere and yet the very publications that ought to be most interested are either afraid to speak up, or are paid to maintain silence. Is it not laughable? To more particularly emphasize some of the points made in the Journal's editorial we have taken the liberty to have some of the words and expressions placed in capital letters:

The report of the Utah Copper Company for the fourth quarter of 1912 is AN ASTONISHING DOCUMENT. The production fell off to less than one-half of what it was in the second and third quarters, such was the effect of the strike; and the cost of production, as computed by the company, rose from 7.707c. in the third quarter to 14.83c. per lb. of copper in the fourth quarter! This is explained by the decreased tonnage of ore treated and by the lower grade of the ore, which in turn is explained by the necessity of procuring the ore from the low-grade and only partially stripped areas. Anyway the average assay in the fourth quarter was only 1.104 per cent copper against 1.41 per cent in the previous quarter. So large and sudden a drop can only be explained by some extraordinary occurrences, such as the president and general manager indicate in their last report, but it is decidedly disconcerting that in the affairs of this company SO MUCH EXLAINING has to be done, SO MANY EXCUSES have to be made.

The Utah Copper Company is now in its sixth year as a producer, disregarding its preliminary work at Copperton, and during that time it has failed to develop in its annual and quarterly reports any of the steadiness that has been displayed by Nevada Consolidated and Miami, the other great porphyry producers. Five years ago the Utah ore was promised to average 2 per cent copper THAT FIGURE NEVER HAS BEEN REALIZED during a year's operations and while we know it is going to run much less than that, we don't yet know what the actual average is going to be. Nor do we know what the actual average cost of production is going to be, although WE HAVE INCREASING CONFIRMATION OF OUR SUSPICIONS that it is going to be much higher than the 7 or 8c. per lb. that used to be estimated. A variation of 7c. per quarter in the case of a big company is almost unprecedented AND INDICATES AN UNCOMFORTABLE BALANCING OF CONDITIONS, which probably has never been adequately taken into account.

Thus, the labor situation in Bingham since early in September has been very troublesome. There was a strike over the matter of wages. This has been settled, but a shortage of labor still prevails. The present explanation is that men have gone home to fight the Turks. It may be perhaps that PRESENT WAGES EVEN DO NOT ATTRACT THE SUPPLY OF LABOR THAT IS NEEDED AND THAT THE COMPANY CANNOT COMFORTABLY STAND ANY FURTHER INCREASE. These are matters that the Utah Copper Company does not touch upon in its reports.

CROSSING THE WIRES AT ALASKA GOLD MINES

Judging from the statements emanating from official sources the promoters of the Alaska Gold Mines "enterprise" would do well to send out a gang of surveyors to definitely locate the Sheep Creek tunnel. General Manager Jackling has repeatedly said that this tunnel was being driven from a point on the Gastineau channel at the mouth of Sheep Creek and up to the first of the present month no one had taken issue with him on that point, and we still believe that he is right. According to a Geological Survey map which shows the Perseverance claims and the other groups of properties in the Gold Basin section, as well as the Sheep Creek divide and the approximate location of the mouth of Sheep Creek canyon, if the Sheep Creek tunnel was driven in a straight line to get under the Alexander tunnel and shaft workings—its admitted objective point—its course would be practically due north.

However, Hayden, Stone & Co., in a market letter about the first of the month, knocked these calculations into a cocked hat. After describing with con-

siderable detail the character of the development in the Alexander tunnel workings in the Perseverance ground, the letter goes on to say: "Now, 10,000 feet to the EAST of these Perseverance workings and 700 feet below them, the Sheep Creek tunnel has entered this deposit. The tunnel has been turned to parallel the vein," etc.

We don't care to get deeply mixed up in this question of location, because it makes no difference to us one way or the other. But you people who may be contemplating the contribution of your mite toward the successful flotation of the scheme in the belief that you will some day get your money back, at least have a right to know whether that tunnel is being driven from the east or the south; and it is also worth while to know what claim the company has to the deposit that Hayden, Stone & Co. contend has been entered by this Sheep Creek tunnel "10,000 feet to the east of the Perseverance workings and 700 feet below them," providing the deposit contains anything of value.

We mention these discrepances particularly because they serve to illustrate how little the promoters of this proposition care what character of "dope" is peddled out to the public, so long as it "LOOKS BIG and will have a tendency to "get the money." In the various statements put out by Manager Jackling, Hayden, Stone & Co., George L. Walker and others during the past few weeks, other misstatements and inaccuracies just as glaring as the ones noted could be pointed out, but what is the use? The publicity agents of the promoters will be pouring "hot shot" into the ranks of the "investors" by the cartload between now and June, when the second payment of $5 per share will be due, so there will be ample opportunity for further comment.

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When intelligent men like newspaper editors, city officials, educators and so forth, read carefully through the smoke studies made and published by Mines and Methods, showing beyond the last vestige of doubt that the smelters are the nastiest of our smokers, and will then advocate an "investigation" to find out where the smoke comes from and otherwise indicate a lingering disbelief, we are reminded of the old farmer at the circus, who had stood in studious silence for several minutes looking at the giraffe. After having critically eyed its uneven legs, its odd sloping back, its derrick-like neck, its dreamy eyes, and its flexible hand-like lip, he at last turned away in disgust, remarking, "Shucks, they can't fool me; there aint no such animal!"

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Most of the tin produced comes from alluvial deposits.

"Garfield" Milling Methods a Failure

In reference to the article on the "Management's Apologies for Butte and Superior" appearing elsewhere in this section of Mines and Methods, and which explains the actual conditions obtaining at that property, we are fully substantiated in all our estimates and criticisms of this "great enterprise" by circumstances which have developed within the past few days, notwithstanding Manager Jackling's assurances given in the published interview contained in the Boston News Bureau of the twelfth ultimo.

> **"The attempt to treat the Butte and Superior ores by the Utah Copper methods has been admitted a complete failure by the management. The Garfield mill practice employed is to be abandoned. A new mill superintendent is coming from Missouri."**

The above in substance, clearly outlines the situation at Butte and Superior as contained in telegraphic advices to Mines and Methods from Butte as we go to press.

In consideration of this latest development we wonder what Hayden, Stone & Company, the Butte and Superior stockholders, and the general investing public, now think of the information contained in published interviews by the management, and in the "bankers" market letters, in which numerous statements were made, unreservedly, that the Utah (Garfield) system of concentration had solved the problem of successfully treating the Butte-Superior zinc ores; that an increased tonnage of ore could be treated, and that a recovery of 85% of the zinc mineral content of the ore was being made which, on the basis of treating 36,000 tons of ore monthly, would return a net profit of $200,000 per month. Compare the actual results obtained from the operation of the Garfield system of concentration (which have been given in Mines and Methods for the past three months) with the claims of the management, and the absolute necessity for the action taken (as outlined in the above mentioned telegraphic dispatch) will be apparent. However, it must not be considered as final that the appointment of a new superintendent will effectually clear the mechanical, metallurgical, or financial atmosphere surrounding the property, and permit the recovery of the stock market to a price above its present quotations. To the contrary, it should be borne in mind that there was not, nor can there be, a time, regardless of the managerial or engineering direction of the Butte and Superior properties when the real value of the stock—based upon the legitimate earning-capacity of the mines—would justify the command of anything like the present market quotations for its stock. This will be apparent when we consider that the mine, according to the management's own statements, does not contain a sufficient tonnage of ores of commercial grade, and that even under the most efficient management, economic conditions preclude a low production cost of zinc.

It is a matter for congratulation, however, that the sponsors of Butte and Superior have been able to evade in this instance the hypnotism under which they have been laboring so long, sufficiently that an effort is now being made to save something from the wreck.

Finally, without dwelling too long on the subject, we want to ask our readers, Hayden, Stone & Co., Geo. L. Walker, the Boston News Bureau, the Guggenheims, S. W. Eccles, and all the rest of the hypnotized following of the practical jokers who have been posing, and have been posed, as the "greatest engineers in this or any other country," where they expect Utah Copper, Ray, Chino, and Alaska Gold Mines, to land. Let's hear from you. Space in Mines and Methods is at your disposal.

Management's Apologies for Butte and Superior

In the January and February issues of Mines and Methods attention of readers was called to the actual operating conditions at the Butte and Superior property under the new management, which is largely composed of the same element which dominates Utah Copper, Chino Copper, Nevada Consolidated, Ray Consolidated, and Alaska Gold Mines. The information published, which clearly outlines the actual facts, was derived chiefly from the offical records of the Butte and Superior company, and is representative of its operations despite the statements in contradiction thereof by the new management, through published interviews, and by the "bankers" through market letters.

Under date of February 12th., 1913, the Boston News Bureau published an interview with Mr. D. C. Jackling which purports to be a thorough explanation of the Butte and Superior situation, and from which we quote:

A year or so ago Hayden, Stone & Co., in behalf of their associates and clients, acquired a substantial interest in the Butte & Superior Co. At that time certain work was being done in respect to the metallurgy of the ores, and plans had been prepared for the construction of a new mill along lines which it was hoped would solve the problem of extracting zinc at a satisfactory commercial profit from these high-grade (20%) but refractory ores. The people then in charge were very sure of their ground, and we did not feel that we should interfere too strenuously and make too many suggestions until they had demonstrated what they could do.

They built a mill and started it up on a small scale of operations, getting fairly good results, but these results could not be secured on large tonnages, and of course, the big mining profits are made only when milling plants are run at maximum capacity.

At this juncture, I and my engineers looked into the proposition very carefully, and suggested some changes that were made. We had previously insisted that the arrangement of the buildings should be such that capacity could be easily increased, and an orderly arrangement of operating units provided. The tonnage treated at that time was relatively small, and the various departments of the mill did not work harmoniously; it was like a strong chain with weak links in it.

There was, however, some excuse for all this. It was a new proposition, and never before had an attempt been made to treat this particular character of ore on a huge scale.

We have now been working on the proposition until we feel that we have solved all fundamental problems, although we are yet to determine just what rate of extraction will be the most economical and it takes time to develop and apply improved methods and arrangements and to perfect adjustments of them. All sorts of sensational recoveries can be made in laboratory or experimental tests; it is quite another matter when a large volume of ore is to be concentrated. We are now not only on a commercial operating scale so far as metallurgical results are concerned, but on a profitable one as well. We were delayed in the receipt of our compressor, new hoisting engine, and in the matter of underground transportation facilities. These delays, however, are not unusual, and the impatient stockholder should always have the "delay" contingency in mind. The consequence was that we did not start up our new hoist until a month and a half ago and we have only been in real operation since about the first of January.

Today we are getting better than an 80% extraction, and I believe that within a few months we will be able to work the proposition up to the point of handling 1200 tons per day, with a higher yield from the ores, and at a cost which will be entirely satisfactory.

Last month we produced over 5000 tons of concentrates, or 5,000,000 pounds of zinc. We produced 18,000,000 pounds of zinc last year.

In March we hope to treat 800 tons per day with a production of 7,500,000 pounds of zinc and to gradually increase this up to 1200 tons per day. The daily treatment of 1200 tons of ore, or 36,000 tons per month, should yield us over 10,000,000 pounds of zinc in concentrates.

Manager Jackling's review of the Butte and Superior situation as outlined in the above should not be given serious consideration—in short, no consideration whatever—if the actual facts are desired. In reference to the construction of the original 1,200-ton concentrator on the property, it is advisable to call attention to the fact that the original plan of concentration therein installed was based upon the most modern practice for treating zinc ores; that it had been thoroughly worked out under the most severe operating conditions at the old Basin mill over a period of two years treatment of the Butte and Superior ores; that it was fully adapted in every detail to treat its normal tonnage of 1,200-tons daily, and to recover the maximum percentage of zinc mineral from the ores treated; and finally, that the original installation of the milling equipment was unreservedly approved by Manager Jackling.

Though the new concentrator was not permitted to operate, as outlined in an earlier issue of Mines and Methods, the new "Janneyized" plan of concentration which replaced the original installation now has been in operation for several months, with the result that to date the mill has not attained, either in point of tonnage treatment or average percentage recovery of zinc from the ores, the results obtained at the Basin concentrator which was operated under the most adverse circumstances.

LAST MONTH'S RECORD.

According to the company's operating record for last month 16,100 tons of ore averaging 1.015% lead, and 19.7% zinc were milled, from which there was recovered 5,154 tons of concentrate containing an average of 47.4% zinc. The percentage extraction is given at 76.85%. In this connection, however, the company's report is incorrect with reference to the ore tonnage treated, and the average percentage extraction. The correct tonnage treatment for the month was 18,716 tons of ore of the general average grade above mentioned, from which an average recovery of but 66.26% of the zinc mineral contained was effected. Further, it is now the customary practice at the property to follow the practice obtaining with reference to the Chino Copper Company, viz., the mining and subsequent shipment of high-grade ore from the enriched areas of the mines (which are limited in extent) direct to the smelteries. In the case of Butte and Superior the zinc content of the ore shipped direct ranges from 28% to 36.4% and the returns therefrom do not appear directly in the concentrator operation records, but through the distribution thereof in the monthly operating report, the account of zinc production from the mill is "doctored" so that the ultimate result is made to appear that the concentrator is effecting a much higher general average recovery of zinc mineral than really obtains.

A peculiar circumstance in the present operation of the new plan of ore treatment is the fact that, in order to treat an average of 675 tons of ore daily it is necessary to use the entire crushing and fine-grinding equipment of both mill units, each unit of which was planned with an equipment sufficient to care for the fine-grinding of 600-tons of ore daily under normal operating conditions. In other words, the crushing departments of both mill units are required to serve one concentrator unit. An idea of the highly efficient and economical milling treatment can best be judged from the information that four sets of 16x42-in. rolls, four 6-ft. chilian mills, two 8-ft. Hardinge mills, and six 4½x20-ft. tube mills comprise the equipment of the two mill units, and these are all in operation to handle the "increased" tonnage of 675 tons of ore daily. Primarily, the reason for this seems to be due to the fact that the "Janneyized" plan of concentration has proved inadequate, and rather than return to the established methods of concentrating the ore, the management has attempted to handle their entire ore tonnage through the flotation plant which originally was intended merely as a trap to catch the mineral not saved by the jigs. This recent "improvement" is an expensive one, and in part is reflected in the additional cost of treatment resulting from the high "mesh-penalty" charged by the zinc smelters, aside from the excessive cost of mill treatment.

In reference to Manager Jackling's statements that Butte and Superior will

earn a profit of $200,000 monthly on a treatment of 1,200 tons of ore daily, we need only refer to similar promises he has made relative to the earnings of the Utah Copper, Chino Copper, and others of which he is general manager, and then compare the actual results obtained from operations for 1912 therewith. As he states in the Boston News Bureau interview "stockholders should always have the 'DELAY' contingency in mind," and in this connection it would be well for stockhloders of Butte and Superior to bear in mind that the management will exercise a marked prerogative in its application, both in the matter of determining "just what rate of extraction will be the most economical" and in the payment of dividends.

Present operating conditions at Butte and Superior do not portend either the earning or paying of dividends for several years. To the contrary, and for reasons hereinafter set forth, it is quite probable that the public will shortly be asked to subscribe additional capital for the continuance of the experiments which are being carried out. At least there will be urgent need for an early disposition of the remaining 65,000 shares of treasury stock, or a consolidation with some other company, if operations are to be continued.

The financial situation of the company is perhaps best illustrated from a review of recent developments which are especially noteworthy and have considerable bearing upon the situation, both as regards the engineering talent of the new management, and the present financial position of the company. Following the assumption of the management by Mr. Jackling and associates negotiations were entered into with the owners of several groups of mining properties (including the Mastadon, Zeus, Snowflake, and others contiguous to the company's chief holdings) on the north and west with a view to their acquisition. Options were taken on the properties after what is supposed to have been a complete geological examination thereof by the Jackling interests (less than two days having been spent on the properties) and the first payment made thereon. The properties taken under option were considered by the management to contain valuable ore deposits, and subsequent payments were made thereon under the terms of the agreement, amounting in the aggregate to approximately $435,000. On March 6th., 1913, the payment due on the purchase price of the properties under the terms of the agreement was passed, and the option rights forfeited. This situation presents a very peculiar circumstance which can be explained in but two ways: That the company was unable financially to meet its obligations, and therefore was compelled to surrender the option rights, or, that the management, after having had the company expend $435,000 on the purchase of the properties, concluded that they were valueless—although there has been no development work performed on any of the properties to date to warrant the action taken.

The information given in the foregoing recital concerning actual conditions at the Montana end of the line should afford a means for stockholders to appraise the value of the stock which they hold in the company. However, to make the situation more lucid it is pertinent to make a general comparison of Butte and Superior operations with those of a well-known, well-managed, dividend-paying property.

Generally considered the market value of Butte and Superior stock at present is $30 per share on an issued capital of approximately 285,000 shares of stock having a $10 par value. The mining properties of the company contain, approximately, two million tons of zinc ore of a general average grade of 20% zinc, a tonnage sufficient to operate its 1,200-ton concentrator for a period of 4.65 years. No profit has yet been made from the property under its new management, and the probability of its entering the dividend-pay class is remote. Under honest, efficient and economical management, with a normal zinc market, the property might possibly earn $5,659,824.18 during its life, or $2,159,824.18 in excess of its entire amortized capitalization of $3,500,000.

On the other hand, as an illustration, the Miami Copper company, with an issued capital of approximately $3,712,875 on its par value basis of $5 per share, having at the lowest calculation 22,000,000 tons of 2% copper ore sufficient to operate its 3,000-ton concentrator for at least 25 years, and earning profits at the rate of $1,474,096 per annum, is given a market value of but $22 per share.

It will be noted, therefore, that Butte and Superior stock at present commands a market price of three times its par value, though it has not entered the dividend class, while the Miami stock commands a price of but four and two-fifths times its par value on a dividend-earning basis of approximately $1,500,000 per annum. There isn't anything that could be more ludicrous than the view which the sponsors of Butte and Superior would have the public take of the situation, nor how little attention the public really pays to actual mining matters. This is more pronounced when one considers that, even before the Butte and Superior concentrator was placed in operation the investing public purchased the stock, up to $52 per share, upon the advice of the promoters of the undertaking. There was nothing to warrant the high price reached by the stock, and there is not now any better reason for maintaining it at $30 per share, only that those who bought in at prices ranging from $40 to $50 can not sell—owing to the failure of the management to make good—and the controlling interests under the peculiar predicament in which they have placed themselves are now compelled to hold their stock till a plan is determined whereby they can again create an inflated market for their securities, and sell out on the rise.

"PORPHYRY" DIVIDEND FLUKES

No dividend from Ray Con.

No dividend from Chino Copper.

No EARNED dividend from Utah Copper.

No EARNED dividend from Nevada Consolidated.

These four paragraphs speak volumes for the real conditions under which the wildly boosted, "masterfully managed" low grade "porphyries" carried greetings to the confiding shareholders at the opening of the 1913 campaign.

It is claimed that Ray Consolidated earned $1,781,531 during the year 1912 and that Chino's earnings reached $2,352,822, or $2.83 a share on the outstanding stock. However, in the case of each, Mr. Charles Hayden, of Hayden, Stone & Co., "bankers for these two companies," declares that the failure to pay "was based purely and simply upon the fact that the boards of directors of these two companies do not propose to make the initial dividend one which is paid by borrowing money against copper."

If Mr. Hayden's statement that there has been no market for copper for a long time is true and that dividends will not be declared until sufficient money has been secured through the sale of metal to provide funds, how has it been possible for the companies to figure earnings so closely as revealed in the figures given above? How do they know that Chino's earnings amounted to just $2.83 a share if the copper produced is still unsold? There is no question but what dividend payments should be deferred until there is money with which to cash the checks, and there is no legitimate kick coming against the directors for declining to take dividend action when they knew that the checks, if issued, would be marked "not sufficient funds" by the bankers. What is true of

Chino, of course, is also true of Ray. But let that pass.

What the public and the investors in Ray and Chino shares would like to know is why did the company managements wait until the last minute to make known the fact that promises were not going to be lived up to; that the "underlying fundamentals of the copper market" were not as sound as so strenuously and persistently claimed? When these men laid awake nights to conjure up statements depicting what great earnings these companies were making and how easy it would be to pay two or three times as much as it was proposed to pay at the start, did not they know perfectly well that gross deception was being practiced? If not, they must be classed as dullards; if they did know and understand, why is the government overlooking them in its "get-rich-quick" prosecutions? If they knew that the copper produced by these mines was being held up so that the Utah Copper Company's product might be converted into cash; if they knew that the case of the latter company was so much more urgent than those of Chino and Ray—because Utah was already in the dividend list and making wilder claims than any of them—why did not that fact be given publicity? Why the apparent collusion?

Utah Copper, it would seem, had to be protected at all hazards; the money JUST HAD TO COME to meet its dividend requirements, because the claim of a huge surplus and constantly increasing dividend-earning power was being ascribed to it all the time—$6, $8 and even $12 a share might be expected from it this year—and to have been compelled to trim the usual quarterly payments from 75c. to 50c. or 25c., when $1.50 at least was logically expected, would have been calamitous. The showing was humiliating enough as it was. To close the last quarter of the year with a deficit and have its partner, Nevada Consolidated, make a similar exhibit, was certainly sufficient cause to bring about a state of nervous prostration in the Utah household—a state or condition so graphically illuminated in the reams of excuses and apologies reeled out by the publicity staff of the management—most of it at the dictation of "Managing Editor" Jackling.

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"NO SMOKING" PLEASE

If tobacco smoking were agreeable alike to those who smoke and those who do not, among men, women and children, the "No Smoking" sign would be obsolete; but the unique pleasure and comfort of tobacco smoking, personal and private as it is, has been carefully curbed by business and society everywhere, for the reason that some other person might dislike the odor.

Time was, in old New England, when tobacco was so common that the best men of society smoked it in the presence of ladies; yet those times are gone, and nowadays public opinion forbids it, when it interferes with the peace of another! One man's rights end abruptly where another's rights begin, is the edict of common sense.

At first, it was embarrassing to post a sign against a friend, or a business associate, asking that he refrain from the pleasure of a smoke while in our presence, and that he please retire to another room (or over into the next valley!) when he wished to start his "smudge;" yet gradually the greatest good to the greatest number has pretty generally been effected, and the smoker no longer expects to smoke indoors in public, except in certain, limited, secluded places; yet, he also knows he may smoke in the "smoker" without fear of giving offense to anyone.

However, should an occasional offender break the rule, any lady can ask him to desist, and feel that not only every bystander and every public attendant, is ready to support her and assist in pushing her request, but she can feel that the great heart of the community is back of her and that no fair thought anywhere is opposing her.

This is what "society," "business" or "public opinion" has done, and this is just what public opinion is doing for the large city that smokes. The smoking of the few, profitable and advantageous as it may appear to the owner of the smoking apparatus, is offensive to the many, and prohibition is being more and more effectually enforced everywhere.

Practically every large city in the United States has its smoke inspector, who is an engineer of several years' training, and who is supported by a corps of expert assistants. Smoke prevention is as plainly a part of city government as street grading or sewer laying, and is regarded as such in scores of cities; and when it becomes so in Salt Lake City, by the shaping of so-called public opinion, we will have smoke prevention laws, ordinances and departments as up-to-date and effective as Des Moines, Chicago, Cincinnati, Cleveland, New York, Pittsburgh, Washington, Boston, and every other fuel burning, but self-respecting city in the land.

Salt Lake City's present smoke ordinance provides that "it shall be unlawful * * * for smoke to be emitted or to issue from (certain boiler) chimneys," and the fine provided is from $5 to $50 for each offense. Yet, because of the lack of public approval—publicly and openly and plainly expressed—even this much smoke regulation cannot be satisfactorily enforced by a political servant of the aforesaid public. The repeated arresting of the city's business-men for letting their furnaces or smelters smoke in our faces does not yet meet public approval in Salt Lake City, and until it does receive moral support, as does a fine for trespassing, exceeding the automobile speed limit, etc., those charged with the duty of smoke abating will have a hard time and do poor work.

A government engineer in the U. S. Bureau of Mines, reporting on the success of smoke abatement work, says: "The most important conclusion reached is that smoke abatement by ordinance cannot hope to succeed unless supported by public sentiment. * * * The greatest advance has come in the past and must come in the future through the organized effort of the city smoke department, supplemented by the active co-operation of the citizens."

And when public sentiment supports and co-operates with, and encourages the smoke department, the inspector's work will become effectual. In a report on the eminently successful smoke prevention work in Chicago, it is stated that many causes contribute, "however, one of the principal contributing factors to the lessening of the smoke from the hand-fired plants has been the knowledge of the firemen that their stacks might at any time be watched by an assistant inspector."

After the support and encouragement of public opinion is given, without discrimination, and the smoke department feels that it can perform its duties without fear of disapproval (or perhaps dismissal) better laws and ordinances must be made and enforced.

Some of the provisions of smoke ordinances that other, much cleaner, though far larger cities, than Salt Lake City, have, and which we do not have at present are: A STATE LAW ENABLING THE CITY TO DEFEND ITSELF AGAINST LOCOMOTIVES, MANUFACTURERS, AND SMELTERS, LOCATED OR RUNNING OUTSIDE, BUT OFFENSIVELY NEAR THE CITY LIMITS. Wisconsin has such a law, and the ordinances in Denver, Colorado, are applicable to Denver county, which covers fifty-nine square miles. Locomotives have not been allowed on Manhatten Island (New York City) for several years; vessels in either the Hudson or East rivers must not emit smoke; neither may even an automobile smoke on lower Broadway.

"No Smoking" signs should be as

sacred to Salt Lake City in the way of fresh air commandments as to New York City, Milwaukee or Denver, and the sign should be on every furnace door in Salt Lake City and county, for exactly the same reason that it should be conspicuous in public waiting rooms for ladies.

Public sentiment is more powerful than law; it makes law, and public sentiment crystalized in, and led by, the Commercial Club, the city officials, and the newspapers, can not only encourage and enforce adequate smoke abatement measures in the city, but it can cause the removal from the valley of the smelters, which are the greatest offenders, and then make laws to keep them, and all other obnoxious plants, in a respectable condition, or out of reach of the nostrils of a clean city.

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FRENCHMEN TALK OUT IN MEETING

That the Frenchmen are "out of sorts" over the manner in which they have been bamboozled by the Butte and Superior promoters, is indicated in the following from the French financial journal, L'Argent, of February 7th:

"American journals inform us that although this enterprise (Butte and Superior) is still an experimental one, nevertheless an attempt has been made to place its shares with the small investor at a profit of 420%. Those who were imprudent enough to subscribe to them have already lost 91 francs per share.

"Early last November we were the first of the financial press to warn our readers of the new attempt made by the Butte and Superior Copper Company against the nation's small investors. We are glad for those who profited by that cry of alarm. Certainly things have happened to justify us beyond our expectations. The shares of $10 par, or 51½ francs, were, in effect, presented to (French) capitalists with a profit of 420%, or at 266 francs. Since that time AND IN SPITE OF THE EFFORTS OF THE PROMOTERS, the course of the price has been a PROGRESSIVE DESCENSION. Recently it tumbled to 175, or a brutal loss of 91 francs per share. Those who imprudently put coupons in the cog wheels swear—if somewhat late—that they will never again be caught.

"The introductory prospectuses mirrored the most brilliant perspectives of the future; and that was easy then because, up to the present, the enterprise has produced nothing. There is, nevertheless, one result of which no explanation is given, namely, the loss of sixty per cent undergone by the first (French) shareholders. The Company was founded in 1906 to explore for copper, as its name indicates, but by a curious and unexplained phenomenon, actual operations contemplated only the extraction of zinc. At the beginning the promoters mistook the kidneys of zinc for the glimmer of copper, (les vessies du zinc pour les lanternes du cuivre) or else they probably found themselves involved in the impossibility of treating the copper.

"Under these conditions we ask ourselves whether their new and later attempt will be more successful. Veins can exist from which no profitable extraction can be made. The reports received by us clearly indicate that the director, M. Jackling, also a director of Utah Copper and Chino Copper, has been compelled to put the valuation of his orebodies in the best light possible. Meanwhile, with an unspeakable audacity, THEY EXTRACT GOLD FROM THE FRENCH FLEECE.

"That M. Jackling is not sure of the proposition, and is experimenting, is the impression gained from an interview in the Anaconda Standard, passages from which we are glad to be the first to give our readers. To the question of our confrere, the porphry magnate, (le magnat porphyrique), has responded: 'In the first place, although the new section of our mill has not been operating long enough to permit a definite judgment on the efficacy of our new process, still WE BELIEVE we have installed the true system, and WE BELIEVE, AFTER A TRIAL OF THREE DAYS, and COMPLETE INVESTIGATIONS which were made before the installation, that we have found the right method.' M. Jackling added that the new process had many points analagous to those employed in the treatment of the Utah Copper. A concentrating table replaces the jigs, and the system is a dry process instead of the usual wet process. * * * The section will treat 600 tons of ore every twenty-four hours, and with the other sections of the mill altered for the new process, the tonnage of the Butte and Superior will attain close to 1800 tons a day. The new process for the treatment of the refractory zinc ores is very satisfactory and advantageous. Sections to the north and east of Butte are very rich in zinc, but up till this time it has been difficult to find a process of treatment, and attempts in this direction heretofore have been very expensive. We have all reason to BELIEVE that the difficulty has been surmounted.'

"As it is easy to imagine, we are far from this certitude, and on this subject the luxurious American magazine, Mines and Methods, directed by technicians whose competence is a guarantee of exactitude, makes judicious comment as follows: 'The assertions of Director Jackling on the subject of the merits of the new process ought not to be taken seriously either by speculators or by engineers. The replacement of jigs by tables, making of the system a DRY PROCESS INSTEAD OF THE USUAL WET PROCESS, does not indicate anything of importance, nor is there, furthermore, any sufficient explanation in the declaration: 'We have every reason to BELIEVE that the difficulty is surmounted.'

"The other operations of the Managing Director are no more precise and denote also a chance conviction. If we consider the charges continually reported in the Utah Copper, Ray Consolidated, and other mills directed by M. Jackling for the treatment of ores, with results equally sterile from the metallurgical and economic view-point, we may be excused for formulating the opinion that the Director was not very certain of himself when he told a reporter of the Anaconda Standard: 'We BELIEVE we are on the right track.' The views relative to future development were not any more precise.

"The journal, Mines and Methods, does not doubt the extent of the zinc orebodies of the region, but merely hesitates to believe that Butte and Superior has found a new method by which a marketable product can be made from the zinc ores. But they point out that Senator Clark, one of the most skillful mine operators, has appealed to one of the most experienced metallurgical engineers to work out some process by which a profitable treatment can be made of ores on the dumps of his mines, which resemble the ores of the Butte and Superior. No result has as yet been obtained, even though the engineer did not ignore the methods employed by the Utah Copper, Ray Consolidated, and Nevada Consolidated.

"In order to be able to judge of the progress of the management of the Butte and Superior with a new 'dry process,' shareholders ought to demand the results of the diverse operations; they ought to inform themselves of the characteristics of the ore, of the elements that make the treatment difficult, of the quality of the product necessary to obtain the best market price, of the output of the mill sections before the changes were made, and the part played by the latest modifications. Stockholders ought not to be willing to declare themselves content with the reports declaring that so many tons of ore have been treated, and that so many thousands pounds of zinc have been extracted. Such indica-

tions will be absolutely insufficient when they relate to the zinc ores of the Butte region, which are known to be so rebellious.

"The promoters forget to give us these explanations. They are even in contradiction with Manager Jackling, who states that the mill will be able to treat 1800 tons of ore per day, while the introducing bankers only claim a maximum of 1500 tons per day. One could not take greater liberties with the public. It is necessary to have an unspeakable audacity to present the shares of such an enterprise to the public with a profit of 420%. It is necessary to count upon the unlimited credulity of the small investor to dare to capitalize at this price the illusions of a future completely uncertain, especially when they are still in an experimental stage. At all events, that the public ought not to allow itself to be taken in, the actual dimunition in price proves conclusively, and the attempt at placing the stock with French investors is a lamentable 'half-baked effort.'"

STEAM SHOVELING BY FAITH

With the application of psychic forces to mining, we may expect some marvelous achievements that are now beyond the powers of the ordinary miner who depends upon brute force. A writer to the Times tells of attending a lecture by Benjamin Fay Mills, who recounted a remarkable story illustrating how a man might eventually move mountains by faith—no steam shovel or deferred stripping accounts required. Mr. Mills incidentally was unfolding a theory of psychology under the captain of "The Psychic Powers of Man." "Strange faiths are abroad in the world," the writer comments, "and I was not so much surprised at the wildness of Mr. Mills' theory as I was at the avidity with which the gathering of apparently intelligent men and women seized upon it. The address was made up of a smattering of the Bible, Emerson, Professor James, Frederic Myers, Christian Science, hypnotism, and some stories gathered from the four winds. As a proof of his belief that by faith a man could move mountains, Mr. Mills cited the following: "A workman was caught between the wheels of an immense stone crusher, which appeared about to mash him to a jelly, but the man, by means of the tremendous power of his will, gathered together within his frame such force that he was able to shatter the vast instrument of steel." Paraphrasing the words of Horatio: "There needs (a) ghost come from the grave to tell us this" ere we will believe it.—Engineering and Mining Journal.

All of which may be taken as a suggestion that Utah Copper might find an easy way out of abandoning its costly and inappropriate steam shovel methods and try an application of "faith" in removing the overburden from its "mountain of copper." The violent death rate among the miners employed also might be considerably lessened by application of "the tremendous will power" exhibited by the man who fell into the crusher jaws, above referred to.

SOURCES OF POTASH

In connection with the search for potash in the West which is being made by the United States Geological Survey a great number of localities have been visited by the Survey geologists, especially in the Great Basin. Shally desert lake beds, so-called dry lakes or playas, are extensively distributed throughout this region. Most of these playas contain salts to a greater or less extent, and nearly all these salts show on analysis from 1 to 4 per cent or more of potash. Few of these lake beds show evidence of having ever been submerged to a considerable depth, and the deposits that lie in the lowest parts of most of them are probably only alternating strata of clays and saline muds, with thin salt crusts produced by periodic flooding and drying up. Large and massive deposits of crystaline salts can hardly be expected except as the result of the drying up of a very extensive and deep saline lake, or as representing the continuous accumulation of saline matter in a water body during a very long period of time. Record of the existence of such lakes in prehistoric times is to be found in certain parts of the Great Basin region. Contrary to the general assumption, however, the extensive lake basins are in fact relatively few. It is evident, therefore, that the search for the important salt bodies of this type has of necessity been narrowed to a relatively few localities.

The areas in Searles Lake, Panamint Valley, California, and the public land withdrawn from entry on account of their potash content are the lowest parts of two ancient lake basins, whose waters at their highest stage probably connected through a narrow strait. Both basins were filled by overflow from the drainage of Owens River and in both the salts are believed to have accumulated by natural concentration of the normal drainage waters from that source. The salt body in Searles Lake lies at the surface of the ground and was located in claims for the soda it contained, before interest in potash had been seriously awakened. The mud flat that forms the bottom of the Panamint Valley has recently been located in "potash" claims, but without any evidence that can be taken to indicate the existence there of a valuable saline mass. The salt that shows on the surface in the Panamint Valley is relatively insignificant in amount, and tests for potash in the surface salts or ground waters of this valley do not run higher than the average of such salts in mud flats and dry lakes generally. The lands have therefore been withdrawn on evidence of a more general character, the theory being that the former larger lake of the Panamint Valley when it dried up might have deposited a bed of salt as large as or larger than that now existing on the surface in Searles Lake. The Panamint Valley is relatively narrow, and the streams from the rugged mountain slopes that border it have spread their fans far into the center of the valley. Drilling, possibly to a considerable depth, will be needed to test the possibility of buried salt deposits in this valley, and if such deposits are found to be present, it is believed that they will be essentially like those of the Searles deposit.

Columbus Marsh, Nevada, is the evaporation pan of a shallow lake. Analysis of clays obtained in this deposit have shown some exceptionally high percentages of potash. No important beds of clear crystal salts have yet been found in the marsh, and the possible commercial value of such a deposit still remains a subject for further investigation Pending such work these lands also have been withdrawn from entry.

They were discussing the market prospects of mining stocks in the Thornton hotel, Butte. "Now," said one of the party, "there are some good things yet left. Miami seems to be a good buy; Giroux is a good buy, and there are unquestionably other good buys; while its a cinch that it's GOODBYE to Butte & Superior."

"Well informed insiders" gave out the tip a long while ago that a $1 dividend would be declared at the February meeting of the directors of the Chino Copper Co., and considerable stock was bought in anticipation of the initiation of a $4 annual rate. The meeting came and went, and all the outsider has now is the right to sell his stock a few dollars lower and wait until the "well informed" again prophesy dividends.—"By the Way" man in Engineering and Mining Journal, March 8.

ADDITIONAL FINDINGS OF FACT IN SMOKE TRAILER'S PATH

By J. CECIL ALTER.

In a three months' study of Salt Lake's winter smoke and fog problem, scores of little and medium sized facts have been brought to light (above the smoke) that really are no less interesting than the main disclosure, namely, the coincidence in the beginning of operations of the valley smelters, and tne one thousand per cent simultaneous increase in the number of foggy or smoky days, and the following notes are presented for the benefit of those who could not personally follow the smoke trails, wherever the interesting research might lead them, much as they may have desired to do so.

* * * *

Clearer skies in summer are due to less coal smoke in Salt Lake City, to the absence of humidity as a more important cause, and to the greater wind velocities as a most important cause. The summer "smoke" is nearly all from the smelters, and shows distinctive color in the absence of the coal smoke and the moisture particles. The fewer rain storms to precipitate this smoke and wash the air clean in summer, are made up for by the stronger winds, which carry more of the smoke away.

* * * *

In weather folklore the adage says that when the smoke columns rise straight and very high, it is a sign of fair weather; and so it is, yet the cause of this rising of the smoke is the higher barometric or air pressure; yet this is the very condition under which Salt Lake City fogs are most numerous, persistent, and dense.

* * * *

When the barometer is high, the city smoke rises higher if not disturbed by winds of unsteady velocities or directions. This is because the denser air has greater lifting power, that is, it is more buoyant in its effect on the smoke. And here we may observe, that if the Salt Lake valley were at sea level, instead of three-quarters of a mile above, the air would average sufficiently dense to lift the smoke and smelter gases much higher above the city all the time

* * * *

CLEARING THE SKY.—A good rain storm usually clears the atmosphere very effectively. This is due to various causes, but mainly to the greater wind velocities accompanying storms than accompany fair weather; and to the "washing" of the atmosphere by the passage of the rain drops through it, which gather dust on the way down. A fresher, purer condition of the air also results from the combining of the sulphur-dioxide gas with the water that is on the way down; also, the rain drops carry down fresh uncontaminated air from aloft, forcing it to replace much of the lower air mechanically; and thus we get an invigorating freshness of air after a good rain.

A snow storm brings none of these clarifying influences but the wind, to any important extent; the velocities of the falling snow flakes are too slow to bring down the fresh air, or to capture and

IN A FIFTEEN-MILE WIND FROM ANY DIRECTION THE CITY IS REALLY CLEAR, AS IT WOULD BE IN A CALM, IF SMOKE CONDITIONS WERE HANDLED.

force to earth nearly s^ many dust particles. Morover the annexing of the sulphur dioxide gas by snow is probably very limited.

* * * *

Farmers residing near Murray say that when the smelter smoke is blowing groundward so that one is forced to breathe it, the fumes are very oppressive and painful, because of the sulphur dioxide gas. An expert for the farmers says that about ninety-five per cent of the sulphur in the smelter smoke is sulphur dioxide.

* * * *

THE WIND AND THE SMOKE.—Notes made while making observations from various places around the city show some interesting facts on the relation of the wind to our smokes or fogs.

A northeast wind, as light as six miles per hour, will clean the city in thirty minutes.

After light southerly winds have been blowing several hours, it requires a fifteen miles per hour southwest wind, or a twenty miles per hour south wind to clear the city in thirty minutes, and it sometimes takes even longer.

A light wind ranging from two to four miles per hour for several hours from the south or southeast or southwest has filled the city and obscured the sky.

Smoke or fog is never recorded in a northwest wind of any appreciable movement.

Studious comparisons of the trend of the smoke trails over various parts of the valley with the wind vane records of the U. S. Weather Bureau, show them to be very similar, though sometimes a southwest wind at Midvale will become a southeast wind in Salt Lake City, by glancing from the mountains; or in very light winds which show the lack of a general sweep across the valley.

A fourteen mile southeast wind kept the city clean and blew the smoke out over the Great Salt Lake flats (January.)

January 9, 1913: A thirteen miles per hour wind from the southeast blew from 8 a. m. to 9 a. m., and at 9 o'clock the city was clear, except in the extreme northwest portion, where the smoke cloud had accumulated. The wind at the Murray smelter was southwest and calculating the velocity by comparing the flatness of the smoke trails with the smoke trails in the city, it was probably blowing about the same velocity as in Salt Lake City, or about twelve miles per hour. An opaque fan of smoke ran from the smelter northeast to Westminster Heights, growing thinner, toward the Heights, though even there, the college and other buildings were barely visible from the Boston building; the vertical depth was about half the apparent height of the mountains; the top surface was well defined, and the entire depth of the layer was of about uniform capacity from top to bottom, judging by the color.

An alleged clear day, looking north through Main Street from the Boston building. This is a view taken from the same point as that disclosed in the large, clear picture.

Later in the day, after one and one-half hours of a more southerly wind, the smelter smoke spread or veered and extended in an apparently straight line from the smelter to Popperton and Federal Heights; at this time the view was gray at Eighth or Tenth East streets, as viewed from the Boston building roof. Most of the south end of the valley was behind the gray haze, but all this morning from 8:00 a. m. to noon, a twelve to fourteen miles per hour wind from the southeast over the down town portion of the city, (and the Weather Bureau windvane) kept the city perfectly clear of smoke.

Judging by the way the smoke lies, as it leaves the chimneys along the Jordan river, and over the business section of the city, it is quite probable that both northwest and southeast winds are of higher velocities on the extreme western edge of the city, and along the center of the valley, than in Salt Lake City.

In a three mile per hour south wind (after the lapse of an hour, in which just three miles of wind were recorded) buildings six or seven blocks away from the Boston building roof were scarcely visible; the sky was blue, showing the obstructing smoke to be thin and low, though it was everywhere obstructing the view about equally in all directions. And when viewed from the tower on the Boston building roof, one hundred and ninety feet from the street, the haze or smoke was seen to be just as dense and as continuous at and beyond the city limits to the south toward the smelter, and beyond the range of the city smoke stacks. The Murray and Midvale smelter stacks were not visible.

The smoke stacks at the Midvale smelters are nearly always visible when the "fog" is not enveloping Salt Lake City, but when ten miles of wind from the northwest blew in an hour, the south end of the valley had clogged so full of smoke that the stacks were not in sight. The entire valley north of a line east and west through Murray was crystal clear. The Midvale stacks are twelve miles away; when this ten miles per hour wind had continued three hours longer, the Midvale stacks were just visible against the gray smoke bank.

Very little smoke has been seen to pass out of the valley to the south even in a good northerly wind. The gorge affording exit to the railroad at the Jordan Narrows is about 4,600 feet above sea level, or 350 feet above the railroad stations in Salt Lake City. However, the general wind routes over the Narrows is about 5,000 feet above sea level, or practically the elevation of Fort Douglas. Since the smelter and city smoke usually hangs within 750 feet of the ground, after it has been cooled a short time, it will be seen that very little of it can be forced out of the Jordan Narrows, for the top of the smoke level averages just about the same elevation as the mountain ridge, through which the Jordan river breaks on its way to the Salt Lake valley.

In a fifteen to eighteen mile northwest wind over the city, maintaining a perfectly clear view over practically the entire valley, Stansbury Island, in Great Salt Lake, is often invisible, and it would seem that the smoke or haze has been becalmed, or blocked north of the Oquirrh mountains. This occurs only after a long and fairly brisk southeasterly wind, which

which carries the smoke out toward the lake. Under all ordinary circumstances, Stansbury Island is plainly visible from the city, though it is nearly twenty-five miles away.

A twelve mile wind from the north sags the smelter haze in a pretty curve from the north end of the Oquirrh mountains through Murray, or sometimes Midvale, and up along the Wasatch mountains to Westminster Heights, or thereabouts; the Midvale smelter stacks feeding the smoke bank to the south were faintly visible during this wind.

A northwest wind of fifteen miles per hour followed by an eighteen mile wind the next hour, left the black Midvale stacks rising naked into the clear air, revealing the full view of the ridge at Jordan Narrows, a very rare occurrence. A faint gray haze appeared, unmistakably, beyond the Narrows, indicating that our smoke had been driven into Utah valley. The Oquirrh mountains were invisible throughout because of the remnant of smoke not caught by the northwest wind.

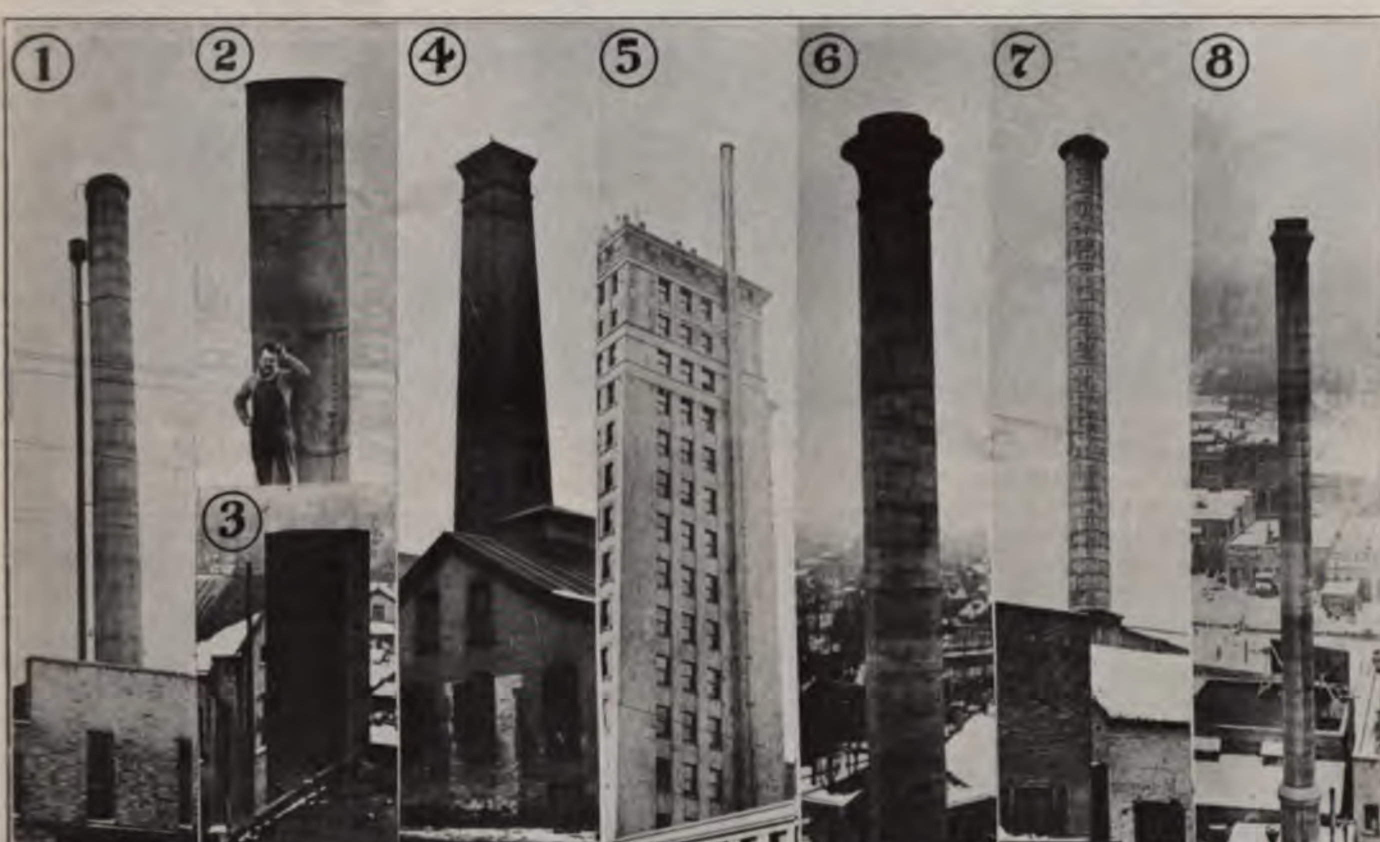
* * * *

CITY FURNACES NOT TO BLAME.—Professor E. H. Beckstrand, of the Mechanical Engineering Department of the University of Utah, says there are forty tons of unconsumed carbon and other substances thrown into Salt Lake's atmosphere daily. This estimate, he says, is 2 per cent of the total coal consumed, while in London the smoke is as much as 6 per cent of the coal.

If forty tons is 2 per cent, then 100 per cent of the coal used in Salt Lake City is approximately 2,000 tons a day. It has already been shown in these columns that 80 per cent of this daily consumption of coal is used in the residence section, and 20 per cent in the business section and in the railroad yards. Therefore, the amount consumed in the business district and railroad yards is 400 tons daily. A careful canvass has been made in the down town districts, and the interesting facts disclosed that 132 tons of this daily consumption of 400 tons is burned in furnaces which are fed by mechanical stokers and which do not emit smoke more than an hour or so a day. Moreover, the smoke that does come out when the grates are being cleaned is very thin and light compared with even residence smoke.

As a general rule, the mechanically-fed furnace smokes a little about five times in twenty-four hours, and each time for from three to ten minutes, while the grates are being cleaned.

Nine heating plants supply heat and power, and in most cases lights, for sixty of the city's largest buildings down town, and consume 132 tons of slack coal daily, as a winter average, and with practically no smoke. This tonnage is exactly one-third the total amount used in the business district. It will therefore be seen that attention must be diverted from most of the large down town smoke stacks and directed to those large stacks



THESE PICTURES WERE TAKEN DURING THE PAST FEW WEEKS, AS WEATHER CONDITIONS PERMITTED, TO SHOW HOW WELL REGULATED PLANTS BEHAVE.

(1) The Tribune heating plant stack; supplies heat, light and power for the Tribune, Herald and Kearns buildings and uses six tons of coal per day. (2) Newhouse furnace stack; heats Commercial Club, Mining Stock Exchange, Boston and Newhouse buildings, using twelve tons of coal daily. (3) The Dooly block, old Commercial Club buildings and stores, Mine & Smelter Co., Armory building, Smith-Bailey Drug Co. and Fairbanks-Morse Co. Burns ten tons of coal daily in winter; mechanical stokers. (4) The Z. C. M. I. plant; heats Z. C. M. I. stores and factory and the Empress theatre; consumes thirteen tons of coal daily. (5) The Walker Bank building stack; smokes a little twice a day; furnace burns ten and one-half tons of slack coal a day in winter; fed by automatic stoker. (6) The Bransford stack; serves the Bransford and Emery flats and uses five and one-half tons of coal a day. (7) Utah Hotel, or Church heating plant; heats all buildings and gymnasium, Bishops' building, Utah Hotel, Beehive and Lion houses, Templeton building, Deseret News building, Vermont and Sharon buildings, and Miller flats. Uses Greer chain grate and fifty-five tons of coal daily in winter. (8) The cement stack here shown serves the plant which heats the Judge building, Felt building, six stores on Main street south of Judge building, Colonial theatre and Mission theatre buildings, and burns six tons of coal a day. Beyond this and a little to the left are located the stacks (not shown in picture) that serve the furnaces which heat the present Auerbach store, Linden hotel, Keith-O'Brien store, Brooks' Arcade and all stores west to alley at Freed's. These furnaces consume seven and one-half tons of coal per day and are equipped with mechanical stokers.

in the valley which have no smoke consumers and which never cease their smoking, from night to day, nor from summer to winter, as is the case with the smelters.

* * * *

WATCHING THE SMOKE.—Benjamin Franklin once said that religion is like a fog. Every religious believer is perfectly sure that where he stands is the region of greatest light and that the other fellow is in a much denser atmosphere. This is also true of the smoke problem, if the observer has only limited time and opportunity to make his observations.

One man says a certain stack is "**always** pouring out black smoke" yet there has been watchers put on that very stack, and actual observations show that the stack smokes less than fifty minutes out of the twenty-four hours; but it smokes at regular intervals, while the grates are being cleaned, and these instances coincide exactly with the time our critical observer was on the way to or from his usual work.

Another observer insists he sees the smoke go up from a great stack and that it comes down on all sides and envelops that particular region of the town; yet a careful watch of this, and other stacks, shows that the surface fog or smoke was flowing very slowly across the town and that the smoke from the big stack in question was actually forced by its own great draught and intense heat to rise several hundred feet in an unbroken column above the general layer of fog or smoke and blow away.

It is for this reason the many downtown stacks are wrongfully accused of being the source of the trouble; the observer is like the man in the fog and sees only what is closest to him. The man above the fog, or at some distance away from it sees that all parts of the city are equally enveloped with it; and every one of the scores of careful thinkers and studious men who have driven to the slopes of the mountains or out into the valley early in the morning for a few hours to examine the fog or smoke formation, have been convinced that the smoke problem would be practically the same if every large heating plant in town were left cold all winter.

Looking northeast from the Boston building tower in a fourteen-mile east wind. A really clear city and the mountains in full view from down town—an unusual sight of late.

* * * *

ORIGIN OF THE SMOKE.—What is smoke? "The gases of hydro-carbons, raised to a red heat or thereabouts, without a mixture of air enough to produce combustion, disengage their carbon in a fine powder, forming smoke The disengaged carbon when deposited on solid bodies is soot," says an authority. Automatic stokers (endless belt-like chain grates, or screw or worm feeders) are so arranged that the disengaged carbon is not only mixed with ample quantities of air to provide the necessary oxygen for complete combustion or total consumption by the fire, but this draught carries the smoke over a broad bed of white burning coal to enforce the annihilation of the visible smoke. In a perfect or smokeless burning there go up the chimney the water vapor, carbonic acid gas, nitrogen and sulphurous acid.

* * * *

WHERE THE SMOKE GOES.—Some one asks "where does the smelter and city smoke finally go?" Most of the smelter smoke "dies" in the valley; if there is a northerly wind of good velocity of several hours duration, the smelter smoke trails have been traced through the Jordan Narrows, though as a rule very little of it gets out of the valley in that direction, so far as observations show. This is due primarily to the relatively great specific gravity of the smoke when cooled; it rises pretty well from the stack, in quiet conditions under the impulse of the intense heat, yet it is not in the air more than two hours and usually gets no more than ten or fifteen miles away from the stack till it has settled to the earth and appears as a ground smoke of from fifty to two hundred feet in depth; it also diffuses horizontally, fairly well, so that large regions have about the same texture of smoke covering at any one time.

Also looking northeast from Boston building tower, on a so-called clear day; that is, no clouds in the sky and surface views unobstructed within half mile.

The nearer the earth the layer comes, the slower it settles, on account of the greater density of the supporting air, and the diminished rate of cooling so far re-

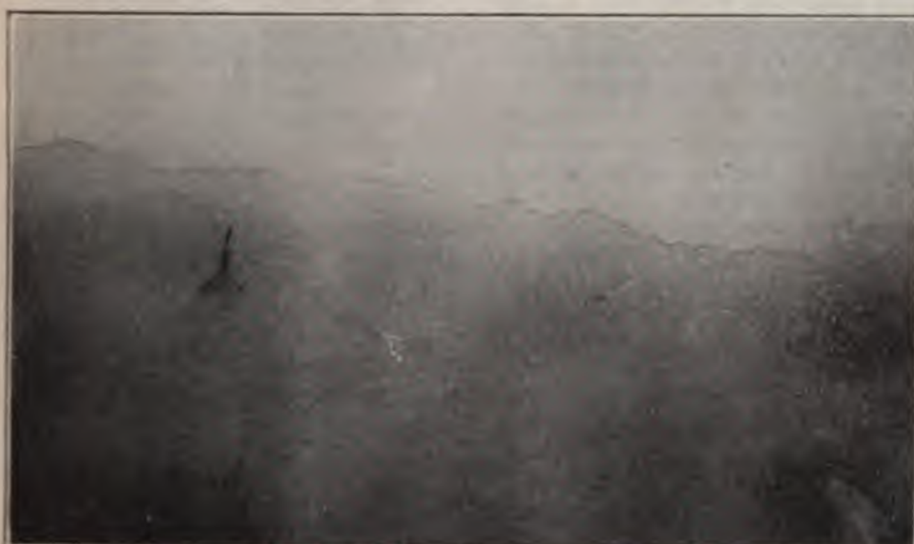
moved from the stacks. In quiet air the smoke has been observed to become very much attenuated in a few hours, indicating that much of its solids have been permitted to settle to earth. When there is considerable wind there is sufficient vertical component of air motion to keep much of the smoke from settling as soon as it would otherwise; but under any circumstances if the smoke remains in the valley, its heavier particles are constantly settling to earth.

However, the sulphur dioxide gas, which forms a very large proportion of the smoke from the smelters, does not settle to earth; it is heavy enough to remain in the lower air strata and to require a gale to force it out of the valley, yet the supply in the air is not appreciably depleted by accumulations on the grounds in low places, ditches, etc. This is because of its great quality of diffusion, acting in opposition to its density.

Once in a long time, a long-sustained southerly wind will force much of the valley accumulations of smelter smoke out of the valley to the northwest, though clarification from this source is so rare as to be of little importance.

As for the blacker city smoke, a southerly or easterly wind will blow much of it easily out of the valley; it is more easily carried by a light wind than is the cool low-lying smelter smoke at this distance from its place of origin. However, with continued southerly winds during the coldest part of the day, when the most coal is consumed, the residence smoke flows over the business section and gradually drops its sooty flakes on the way. It is probable that at least 85 or 90 per cent of the total smoke in the valley never gets out, but remains to clog the air, or ultimately settles to earth.

Coal smoke is not "a lighter-than-air gas which may rise aloft and float away," but is composed of material particles, which are continually seeking the earth under the impulse of gravity. It is estimated that 90 or 95 per cent of the visible smelter smoke manufactured in the valley never gets away, and that 60 to 80 per cent of the city smoke never gets out of this part of the Salt Lake valley.



Looking southeast from Boston building tower, in a dense fog or smoke; City and County building tower showing above fog or smoke.
Taken last month about 9:30 a. m.

Taken same day as dense fog photo, about 3 p. m. A "clear" sky and a "clean" city, as usually observed in these latter days.

* * * *

SAMPLING THE AIR.—The Commercial Club Smoke Investigating Committee received the suggestion that samples of the air and the smoke be taken to determine the contents and thus arrive at the "probable" cause of the trouble. This brings to mind the sampling work done by an alleged expert here this past winter. He worked several weeks and succeeded in securing over forty samples of air at various places in the valley, in bottles having a capacity of a few cubic inches, and in other small containers. In only two of these samples was there more than a suggestion of sulphur, and in these there was only a trace.

Indeed he could not have found more, for a "trace" of sulphuric acid in so small a sample of air is a very full charge of the poison. In fact the total amount possible in an entire cubic foot of air (which is probably several times the amount of air collected in all the forty odd samples taken) could not exceed what the chemist calls a "trace" or the air would be a veritable draught of pure poison into the lungs.

Of course in a small sample of air, fully charged with sulphuric acid, etc., from the smelters, the analyzer must report a trace. Therefore we add to the suggestion to the Smoke Committee that if tests be made, that they be made of at least as much air in one sample as one would breathe in an hour, or enough to actually determine the facts as they may concern the welfare of human beings.

* * * *

SHARE OF SMELTER SMOKE.—Estimates of the proportion of smelter smoke, residence smoke, and furnace smoke, existing in the business district at one time have been made by watching all the fields of smoke from their inception before sunrise till toward noon, from various nearby mountain eminences and from the Boston building tower. In average quiet conditions with very light southeasterly winds, in January, the obstruction was probably one-fourth smelter smoke, one-fourth furnace smoke, and one-half house smoke; in a six to ten

miles per hour south wind, the accumulation changes to from one-third to one-half smelter smoke, which is always distinguished by its color, and the rest residence and furnace smoke, the latter remaining at most no more than one-half the residence production, which is flowing across the business district; mixtures of this kind have prevailed for an hour or so perfectly dense down town, but without the excessive formation of true fog as shown by the streaking or commingling of the various kinds of smoke. Again, moist fog has exerted its strong influence by binding the smoke mass into a more homogeneous and immobile mass; a fact that has been plainly observed from the hills.

* * * *

SEEN FROM ENSIGN PEAK.—One morning's observations from Ensign Peak, beginning at daylight, are here given: The valley was observed to be nearly clear of smoke at first, but several large chimneys in the business section were issuing isolated columns of very black smoke. The city's smoke cloud had not yet formed, and, when it did form, it was not continuous at first.

At 7:30 a. m., just as day was breaking, the lower ground levels of the valley contained a bluish haze of the same color, but of thinner texture, as was hanging low in the extreme south end of the valley. The smoke fan, spreading out from the smelters, broadened rapidly. By 7:45 a. m., (late December, 1912), the residences in the lower eastern portion of the city began their smoking conspicuously, and soon a low continuous smoke layer was flowing westward and joining the isolated streams of denser down-town smoke

The house smoke was lower, more continuous, grayer in color, and was apparently confined to the city below the east benches. The northwest portion of the city was clear at 8:30 a. m., apparently because the westerly drift of the general smoke layer had no northerly component up to that time. From about 7:50 a. m. to 8:20 a. m., the streets down town were closed by the dense smoke; a very light northeast breeze from the bench, against the easterly or southeasterly trend across the city, kept the streets and blocks north of South Temple street clear, so that Utah hotel, the Bransford apartments, and other nearby buildings, were in sight from the peak, showing up against a dark bank of smoke clouds. The density of all smoke seemed to diminish about 8:30 a. m.

* * * *

SMOKE INFLUENCE ON CLIMATE.—Julius Hann, the world-renowned meteorologist at Vienna, says the temperatures recorded in large cities, even where the instruments are properly exposed, far above the influence of reflected or contact heat, are from 0.9 deg. to 1.8 deg. F. too high; that is, higher than would be recorded in that identical place if the city were removed.

This is due in part to the heat from the buildings, part of which originates within the buildings and part from the sun; but it is due mainly to the "smudge" blanket of smoke which usually dissipates enough in the day time to allow maximum temperature to reach a natural or unobstructed value, but which at night or early morning at the coldest part of the twenty-four hours, when all fires are getting started, serves to prevent the natural or normal loss of heat from the earth by radiation.

A century or more of official weather records show Paris, France, city temperatures to be 1.4 deg. F. too high, or above the values from similarly exposed instruments in the adjacent countryside. The regularly published mean annual temperatures of Vienna, Austria, are 0.9 deg F. too high and Berlin, Germany, records are also 0.9 deg. F. too high. All these are very large cities, and doubtless have a large city's share of smoke.

* * * *

SULPHURIC ACID MAKERS.—When the pathological division of the U. S. Bureau of Animal Industry reported that the death of the millions of ducks in the Great Salt Lake marshes was due to "sulphuric acid," the newspaper reporter who handled the story in New York said the acid came from "certain industrial plants," as if they might have been "potato crushers," or "orange sweaters."

As a matter of fact, what the examining doctor did surmise was that the poison came from the beet factories and fruit and vegetable canneries. However, in 1910, the State Fish and Game Commissioner noted that the poison from these plants was killing the fish in the nearby streams and at that time he required all these factories to filter their refuse and waste water before letting it into the streams. Large filtering tanks or pools several yards in extent perform this service quite satisfactorily so that no poison of any sort reaches the streams. The only other sulphuric acid makers of importance in the state, are the smelters.

* * * *

A prominent assayer of this city estimates that there are ten cars, of forty-five tons each, of sulphuric acid wasted in the valley every day that might be used.

* * * *

There would probably be no sulphuric acid problem to consider if the smelters were away, despite the ever-present quantities in coal smoke; as, with prevailing southeasterly wind, this sulphuric acid of the city smoke like the smoke itself, would be passing continually away from the city, and not accumulating like that which comes over the city broadcast from the south, and reaches parts of the benches and the city where no city smoke could ever reach.

* * * *

FREE SULPHUR—In several places in the United States sulphur dioxide is manufactured and sold to folks who are in need of it, and who buy it when they want it, but in the Salt Lake valley, the residents have it forced on them day and night.

The gas is used largely for disinfecting purposes—for instance, in a sick room. It would, therefore, seem that Salt Lake City is pretty well disinfected by the dearly-bought disinfectant. Since the smelters came to the valley, the vital statistics of Salt Lake City show a marked decrease in the proportion of, and number of, victims of contagious diseases; and while city physicians claim this to be due to their efforts in various ways, it seems appropriate, at least, to mention the disinfecting performed by the smelters in connection with the decrease of contagion. In this respect it takes the place of some of the sunshine which it obstructs, the city being well fume-gated."

* * * *

SOME DATES—The Hanauer and the Germania smelters were built in the neighborhood of Midvale in 1871 and 1873. The Highland Boy at Murray ran from May, 1898, to Janaury, 1908, the American Smelting Refining Company's plant at Murray began operations in 1902 and is still running. The United States Mining & Smelting Company's plant at Midvale began operations October 1, 1902; and the Garfield plant started its various units at various times in 1907, and all are still operating.

* * * *

OBSERVATIONS FROM GRANGER.—Avery beautiful picture is seen from the Granger or Hunter Bench, fifteen miles southwest of the city, on all moonlight nights when fog or smoke has accumulated over the city. The city lights and the moon serve to illumine the smoke, and a beautiful glow is the result, which lasts while the smoke is continuous over any extensive region. This phenomenon results from the same principle that renders a ray of sunlight visible across a darkened room. The tops of the Wasatch mountains are always visible above the smoke from a Granger elevation, which is about the same as the Utah Hotel bee-hive.

WASHOE SYSTEM OF INDIRECT CLASSIFICATION

By AN OCCASIONAL CONTRIBUTOR.

Pursuant to its policy of advancement in the arts of mining, milling, and metallurgy, the management of the Washoe concentrator at Anaconda, Montana, recently has completed important changes in the manner of milling the low-grade copper ores from its Butte mines. The principal object in view has been to increase the concentrator mill unit normal capacity, and, incidentally, to effect a higher general average recovery of the copper minerals contained in the ore treated. The results obtained from the changes to be hereinafter outlined have proved eminently satisfactory, and the entire mill flow-sheet will be rearranged according to the proposed plan of concentrating which has been in operation in Section 1 for several months.

Primarily the plan of concentration installed in Section 1 of the Washoe concentrator considers closer classification of the material treated by means of an indirect system of classifification. In the application of the indirect system advantage is taken of the almost complete elimination of slime at each successive sizing operation and the arrangement of the classifiefirs in a manner that will permit the elimination of slime from the resultant product of the rolls, mills, etc., during the different stages of crushing. Further, the plan of indirect classification as at present employed is not unlike other systems of direct classifying, as in the case of the Richards and others of the same general type.

The ultimate result is in both instances, however, the same, or nearly so. The marked advantage of the indirect system lies in the fact that, in lieu of attempting the close classification of pulp during a single operation advantage is taken of the elimination of slime at successive crushing stages as hereinbefore mentioned, and the remaining material subjected to but a simple separation of fines from sands which products are in turn treated on machines best adapted to the treatment thereof. Through a gradual elimination of the free mineral contained in the pulp the resultant middling is subjected to the necessary regrinding and by a system of progressive classification the various sizes (other than slime) of material are transferred from one series of classifiers to others, either directly or indirectly, but generally following the preliminary treatment on jigs or tables. This will be more clearly outlined in a later paragraph covering the mill flow-sheet.

The classfiers used in the Section 1 of the Washoe concentrator are of the single unit, double-cone, hydraulic type, commonly termed the B. & M.—Boston & Montana—classifier. But two products are made, an overflow and a spigot discharge. Dependent upon the grade of pulp, these products are each in turn treated on separate machines, or at least one product delivered to a secondary classifier for further treatment.

FEATURES OF THE FLOW SHEET.

From the receiving bins the mine-run ore is passed over two 2-in. round hole shaking screens, the undersize going direct to two No. 1 bucket elevators, and the oversize passing through a 12x24 Blake crusher reducing the material to approximately 2-in. ring, then over two 2-in. trommels the undersize from which goes to the No. 1 elevators. The oversize from the 2-in. trommels passes through two 5x15 Blake crushers, reducing to approximately a 2-in. ring, the crushed material then going to the No. 1 elevators.

The two No. 1 bucket elevators deliver the 0 to 2-in. material to four 1-in. trommels, the undersize therefrom passing onto four 10-mm. trommels, and the undersize from the latter in turn going to a series of eight 4-mm. trommels.

The oversize from the four 1-in. trommels (approximately 1-in. to 2-in. material) serves two Harz jigs, and the oversize from the 10-mm. trommels (approximately .4-in. to 1-in. material) serves a group of four Harz jigs. This series of six coarse jigs produces a coarse cup concentrate which goes to the blast furnace concentrate bin. The 1 to 2-in. middling from the two first coarse jigs is passed through one set of 24x54 Anaconda type rolls set to crush to ¾ inch ring, and the .4-in. to 1-in. middling from the four last coarse jigs is passed through a separate set of 24x54 Anaconda type rolls set to reduce to approximately .5-in. The roll crushed product is returned to the two No. 1 elevators in closed circuit, the outlet from which is the minus 10-mm trommel or the ¼ to 5-16-in. Harz jig sieves. The Harz jig hutch product, together with the oversize from the series of eight 4-min. trommels, is treated on two coarse feed Hancock jigs, and the 4-mm. trommel undersize is delivered to a group of five No. 1 B. & M. double cone hydraulic classifiers.

The two coarse feed Hancock jigs produce a concentrate which goes to the 3/8-in. concentrate tanks for dewatering; a return middling which is retreated, and a middling-tailing which, after dewatering in one V middling tank, the plug discharge thereof passes the pulp through one set of 15x42 intermediate rolls reducing to approximately 4-mm., thence to two No. 2 elevators to six 4-mm. trommels, the oversize from the latter being returned to the intermediate rolls in closed circuit, and the trommel undersize passing into the five No. 1 B. & M. classifiers.

THE B. & M. CLASSIFIERS.

The No. 1 B. & M. classifiers make two products, an overflow (approximately 0 to .08-mm.) that goes to the total classifier overflow tanks, and a plug discharge (approximately .08-mm. to 4-mm) that passes directly into six No. 3 B. & M. classifiers, the latter producing an overflow (approximately .08-mm. to .75-mm.) which passes into three No. 4 B. & M. classifiers and plug discharge (.75-mm to 4.0-mm.) which serves three fine feed Hancock jigs. These jigs make a fine concentrate which is delivered to one No. 4 elevator, thence to No. 8 elevator serving the fine concentrate bins; a return middling which is retreated on the jigs, and a middling-tailing which, after dewatering in a V tank is delivered to two No. 3 elevators serving eight 1¼x12-mm. trommels, the oversize from which passes through two sets of 15x42 finishing rolls, and returned to No. 3 elevator in closed circuit with the trommels mentioned. The undersize from the 1¼x12-mm trommels delivers to a group of ten No. 5 B. & M. classifiers, the overflow product therefrom (approximately 0 to .08-mm.) going to the total classifier overflow tanks, and the spigot discharge (approximately .08 to 1.25-mm.) going to eight No. 6 B. & M. classifiers, the overflow product from the latter (.08 to .75-mm.) to seven V dewatering tanks, and the spigot discharge (approximately .75 to 1.25-mm.) to a group of nine Wilfley roughing tables. These roughing tables produce a clean concentrate which is returned to No. 8 elevator to concentrate bins; a rough concentrate which is returned to No. 6 elevator and there-

from to the No. 3 classifiers, and a middling-tailing which goes to No. 5 elevator to four No. 7 B. & M. classifiers, the last mentioned producing a middling and a tailing. The tailing after dewatering enters the tail race, and the middling passes through four 6-ft. Huntington mills reducing the pulp to approximately .75-mm., then to elevator No. 3 in closed circuit with the 1¼ 12-mm. trommels. The overflow product from the No. 6 classifiers (.08 to .75-mm.) serving the seven V settling tanks above mentioned is subjected to the following treatment: An overflow from the seven V classifier-settling tanks is delivered to the general slime pond, and two separate plug discharges of the thickened pulp serve individual groups of a series of thirty-two secondary Wilfley tables. These tables produce a concentrate which is sent to the fine concentrate bins via No. 8 elevator; a middling which by elevators No. 7 and No. 6 is delivered to the No. 3 classifiers.

The overflow from the No. 3 classifiers into the No. 4 classifiers is followed by an overflow from the latter classifiers (.08 to .35-mm.) into nine V dewatering tanks, and a plug discharge (approximately .35 to .75-mm.) to a group of ten coarse primary Wilfley tables, which produce a concentrate which goes to concentrate elevator No. 8; a middling that is returned to the No. 3 classifiers through elevators No. 7 and No. 6, and a tailing that enters the race. The overflow from the nine V dewatering tanks goes to the slime pond, and the two separate plug discharges serve twelve fine primary Wilfley tables, the latter producing a concentrate which goes to No. 8 elevator serving the fine concentrate bins; a middling which is returned to the No. 3 classifiers through elevators No. 7 and No. 6, and a tailing which enters the tail race.

The product of the total overflow of the No. 3 and No. 5 classifiefirs goes to a series of twenty Callow cones, the overflow from which enters the total slime tanks, and the plug discharge is delivered to twenty-four fine sand Wilfley tables. The headwater from these tables enters the total slime tanks; a fine concentrate is produced and sent to the fine concentrate bins; a tailing enters the race, and a middling is produced which is retreated on this group of tables together with the new pulp.

The total slime tanks serve twenty-four Callow cones, the overflow therefrom entering the tail race, and the plug discharge going to eight four-deck cement-floor buddles. The buddles produce a concentrate, a middling which is returned for retreatment, and a tailing. In this connection it is interesting to note that, during recent competitive tess of several well-known slime reating machines with the cement-deck round tables, the latter in every instance demonstrated their superiority, and will comprise the principal equipment in the slime treating plant which the company contemplates building.

From the flow-sheet outline given in the foregoing paragraphs it is particularly interesting to consider the classifying system independently of the remainder of the mill, and to more clearly point out the relation which each unit group of classifiers bears to the entire classifier series. For example, the No. 1 classifier considers the elimination through the overflow of the 0 to .08-mm. material from the 4-mm. trommel undersize feed and delivers the product to the Callow settling cones for dewatering, the plug discharge, .08 to 4.0-mm. product, going directly to the No. 3 classifiers. The No. 3 classifiers in turn make an overflow product, .08 to .75-mm., that serves as the feed for the No. 4 classifiers, and a plug discharge, .75 to 4.0-mm., which is treated on the fine Hancock jigs. The No. 4 classifiers produce a .08 to .35-mm. overflow feed which, after dewatering, is treated on a group of fine primary Wilfley tables, and a plug discharge, .35 to .75-mm. that is treated by a group of coarse primary Wilfleys. The middling plug discharge of the fine Hancock jigs passes to the 1.25x12-mm. trommels, the undersize therefrom entering the No. 5 classifiers. These classifiers make an overflow of 0 to .08 material that goes to the Callow cone settling tanks, and the plug discharge, .08 to 1.25-mm., serving as feed to the No. 6 classifiers, the latter classifiers in turn producing an .08 to .75-mm. overflow which, after dewatering, is treated on a group of secondary Wilfley tables, and the .75 to 1.25-mm. plug discharge treated by Wilfley roughing tables. The middling-tailing from the Wilfley roughing tables serves as feed to the No. 7 classifiers, the latter producing a tailing through overflow, and a middling through the plug discharge that goes to the Huntington mills for regrinding, thence to the No. 3 classifier.

It will be noted from the foregoing that, in point of general operation of the classifier series, the individual units consider indirect classification of their respective feed, but, in the aggregate, the series of individual groups of classifiers operate altogether as a direct system. Through the system of indirect classification the individual classifier units give a mixed feed to the fine jigs and tables from which the maximum of free mineral is removed, and the return product (middling) reground and again classified over a different circuit, dependent upon the particular requirement for the product. Slime is rejected at successive stages of classification, but generally through the No. 3 and No. 5 classifier overflow, and removed from the classifier circuit thereafter to be treated separately. This feature of the operations is desirable, and permits the delivery of a comparatively clean sand product to the several concentrating machines.

In general, comparing the operation of the B. & M. system of indirect classification to the direct system represented by the multi-pocket direct type classifiers (Richards-Janney, etc.,) the former has clearly demonstrated its superiority, both in metallurgical efficiency and cost of maintenance. Further, while there is no shortage of water at either the Great Falls or Washoe concentrators where the B. & M. classifier has found its most extensive application, actual operating conditions have indicated that the quantity of water required for the classifier hydraulic is far less than for the direct type machines. This feature is of particular interest inasmuch as it solves an important problem for mills in the arid regions where water for concentrating purposes is at a premium.

Section one of the Washoe concentrator has been rearranged in accordance with the flow-sheet plan hereinbefore outlined, and the remaining seven sections of the mill will be changed to conform therewith as rapidly as possible. Of course, it is to be expected that minor changes will be made from time to time, but the foregoing outline is representative of the general plan of treatment.

The new section is treating an average of 1,500 tons of ore daily of a general average grade of 2.5 to 3.3 per cent copper and effecting an average recovery of 85 per cent of the copper minerals contained in the ore treated. This is an increase of fifty per cent in tonnage over the average treatment of the other mill sections, and a higher comparative general average recovery of mineral.

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Chemically pure gold is prepared as follows: About 10 grams of gold in any form are dissolved in aqua regia and the solution is boiled to expel all free chlorine, diluted to about 10 litres and allowed to settle for about one week. The clear liquor is decanted upon a filter by means of a syphon so that the settled residue may not be disturbed. About two pounds of pure oxalic acid are dissolved in water and mixed with the gold solution and allowed to stand for a week, the clear solution decanted off, the gold precipitate washed by decantation, twice with hot water, once with boiling dilute nitric acid, twice more with hot water.

Extracting Gold From Gravel Deposits (V.)

By AL. H. MARTIN

The gold dredge forms the fruition of years of experiments with more or less satisfactory devices for winning of auriferous values from gravel beds and bars of streams. The most efficient contrivance ever fashioned for extraction of gold from comparatively deep gravel deposits, its employment has spread to all fields wherever the art of the gold miner is known. It is commonly supposed that the dredge is a product of recent years, but its possibilities were recognized and applied over fifty years ago, even though pioneer efforts were most noted for their failures. The sturdy band of Argonauts that flocked into California in 1849 realized the possibility of constructing a machine that would excavate the rich gravel from unfriendly beds and bars of rebellious streams, and soon after Marshall's epoch-making discovery, a machine designed to dredge the inviting deposits was shipped around Cape Horn to San Francisco. The device was placed in commission on the Sacramento river before the close of 1849, and great hopes were entertained by its owners of a speedy winning of gold treasure from the bed of the turbulent stream. But ere long the boat was at the bottom of the masterful river—a monumental failure in every respect. Succeeding years recorded attempt after attempt to place a successful dredge in action in California and other American states, and always the result was the same—failure, thorough and humiliating.

But while attempts at dredging were thus uniformly unsuccessful in America, operators in other fields were meeting with more encouragement. In the early sixties the single bucket, or spoon, dredge was evolved by New Zealand operators. The contrivance in its initial stages was a most crude affair, consisting simply of a heavy bag laced or riveted to an iron frame securely fastened to the end of a long pole. The device was lowered to the bottom of a river or creek and dragged along. The bag was counterbalanced sufficiently that when filled, or nearly so, it could be drawn up and its contents discharged into sluice boxes. Later on a pontoon was used in connection with the so-called bucket, and the material dumped into an auxiliary boat, equipped with washing apparatus. These dredges were at first operated by hand, and later with the aid of current wheels. The first bucket-elevator dredge, as the machine is regarded today, was constructed at Otage in 1867, and results obtained from this and subsequent installations led to the development of the modern gold-dredging industry in New Zealand, and exercised a highly salutary effect on the evolution of the industry in California and other fields. The invention of the steam operated dipper dredge by Ward in 1870 solved the power problem and paved the way for the building of larger and more powerful machines, which were able to handle ground at a cost previously considered as virtually impossible to attain. The idea of the dredge probably followed experiments with the steam shovel, which was employed for excavating purposes years before gold dredging developed, and the modern dredge, representing the most efficient gold recoverer yet devised, most probably was evolved from the ancient spoon dredge of New Zealand and the small steam shovels formerly in vogue.

FIRST SUCCESSFUL DREDGES.

The first successful gold dredges to be operated in America went into commission at Bannock, Montana, in 1894. These boats were of the double-lift, bucket-elevator type, equipped with machinery designed and constructed by the Bucyrus company. The boats operated on Grasshopper creek, and almost from the first proved successful. In 1897 the first single-lift bucket-elevator boat to be constructed in California was placed in action on the Yuba river. It is possible that this installation would have been a success had it been located on some placid stream, but the raging Yuba soon swept the boat on to the rocky shore, and no attempt was made at its rehabilitation. But on March 1, 1898, W. P. Hammon and Thomas Couch placed their famous Couch No. 1 dredge in commission at Oroville, and the era of modern gold dredging was born. This boat was of the single-lift, open-link, bucket-elevator type, and was the result of the experience gained by operators in the New Zealand and Montana fields. From the successful operation of this boat the development of modern dredging has been consistent and rapid.

The first California dredges were generally equipped with 3 and 3½ cubic foot buckets, with a digging efficiency to a depth of 35 feet. Steam was the motive power, but this means of operation soon yielded to the more satisfactory and less expensive electricity. Only the richer sections of ground were handled, but as capacity of buckets became larger, ground formerly deemed valueless was brought within the productive zone. In the brief space of fourteen years the dredge has developed from a small boat handling 1,600 to 3,000 cubic yards per day, at costs of five and six cents per cubic yard, to the mammoth 15-cubic foot designs that turn over 12,000 to 15,000 cubic yards daily, at an approximate cost of two and three cents. And the more modern dredges are excavating to depths of 65 feet and handling a character of material that was formerly considered too difficult for the gold-boat to handle.

A CALIFORNIA DREDGING SCENE.

REQUISITES NECESSARY TO SUCCESS.

The salient requisites of a dredging deposit are sufficient gold content, enough territory to justify the building

of such a costly contrivance as the dredge has grown to be, and practicability of economic operations. Presence of numerous huge boulders, extensive deposits of clay, uneven bedrock and rough surface contour at times nullify what would otherwise be an attractive dredging proposition. Numerous failures have attended dredge installations because of imperfect or unintelligent examination of the ground, as the tendency too often has been the building of an expensive plant before sufficient prospecting of the deposit was performed. The gradual improvement in machinery and increasing efficiency of the dredges have made the work of the engineer less difficult than in former years, as ground can now be successfully dredged that was formerly beyond the compass of the buckets, but the need for caution still prevails,, as numerous late failures indicate. The deposit must necessarily be of sufficient extent to contain enough ground to warrant the building of a dredge and return of principal to the investors, with the 10% always regarded as the minimum rate of interest in the industry. Under ordinary conditions, two 7-cubic-foot boats will turn over 500 acres to a depth of 33 feet in about nine years, with allowances made for lost time. Costs in such instances range from around four to about seven cents per cubic yard. A 15-cubic foot boat would do the same work in somewhat shorter time at a cost of two to three cents. The larger the boat, the lower the working cost per cubic yard, all other conditions being equal, but the building of a costly 13½ or 15-cubic foot dredge is not justified because it operates more cheaply per cubic yard, unless the acreage is sufficiently extensive.

Powerful Natomas No. 10 Dredge in Course of Construction.

In the smaller fields, 5, 7 and 9 cubic foot dredges meet with greatest approval, but in really extensive districts the 15-cubic foot designs are the boats par excellence. As an acre contains 4,840 square yards, the engineer can readily figure the cubic yard content of a deposit, and allowing for ground lost in turning over an uneven bedrock, arrive at the best installation for the proposition under consideration.

The value of any device is proven by its ability to yield results under adverse circumstances. And the value of the dredge is largely measured by the facility with which it handles the most difficult ground. California and Alaska operators have been confronted with many difficult problems in this respect, and the overcoming of such obstacles has been of inestimable value in the development of the dredge from its early type to its present high stage of efficiency. California operators have been particularly progressive in dredge building, largely because they were the first called upon to master problems presented by the growth of the industry. The frozen ground of Alaska,, and the dense tropical growths of the tropics have introduced perplexing questions to operators in these fields, but the ability of the dredge to cope with difficulties fully as enigmatic had already been demonstrated in the Folsom and Yuba districts of California.

A DIFFICULT DEPOSIT.

Probably the most difficult deposit to be dredged in California is the Rebel Hill placers, situated in the Folsom district, in the lower portion of the Sacramento valley. This ranges in depth from 50 to 75 feet, with the first six to eight feet partly cemented. Below this extends a body of compact material to a depth ranging from 25 to 30 feet. The gravel between the compact strata and bedrock is loose and easily worked, but the refractory upper material led early operators to consider the mining of the deposit to a depth of even 30 feet economically impossible. It was apparent that only dredges of the most powerful type cuold be successfully operated, and even then the problem of handling the cemented surface material threatened to defeat the efforts of the most formidable machinery that could be brought against it. But the difficulty was met by the original methods employed by General Manager R. G. Hanford of the Folsom Development Company. A dredge equipped with 73 9-cubic foot buckets was constructed, with every care exercised to make the hull unusually massive to withstand the tremendous strain imposed by the heavy machinery excavating the compact material. Instead of blasting down the cemented graved monitors were used to disintegrate the material with hydraulic streams. Two monitors with three-inch nozzles were placed at the bow, and supplied with water from a high duty centrifugal pump, driven by two 50-horse-power electric motors. At times the water-level of the flotation pond was twenty feet below ground surface, with the first six or eight feet of gravel cemented, but by providing ample washing facilities, the dredge was enabled to take care of the material without difficulty. The two monitors readily undermined and washed down the heavy ground, and the buckets excavated the more loose gravel with comparative ease. The electrical equipment of this dredge (Folsom No. 5) has a rated capacity of 540 horse-power, but in actual operations only about 484 horse-power is required. The pronounced success attending the experiments with this dredge blazed the way for mining of deposits that had previously been deemed utterly beyond the scope of the bucket-elevator dredges, and indicated what might be achieved by devising original methods for handling of individual problems. Folsom No. 5 went into action in December, 1905, a little over seven years after the pioneer Couch No. 1 was launched at Oroville.

Already in 1904 had W. P. Hammon and R. D. Evans demonstrated the feasibility of dredging successfully to great depths, when Yuba No. 1 and No. 2 boats were constructed to excavate to a depth of 60 feet below water level in the Yuba River field. These boats were the first of their type to dig to such extreme depth, and the modern California dredge, the worlds' standard in gold dredger construction, have been evolved on the lines developed and laid down by the builders

of the early Folsom and Yuba machines. The steel hull, now rapidly displacing those of wood in the case o fthe larger dredges, followed a desire to minimize the ever-present danger of fire, and tne necessity of providing a housing material to resist the voracious attacks of the destructive wood eating insects of the tropics. The tendency has naturally been towardt he construction of boats of steadily increasing capacity, when conditions so permitted, because of the lowered working cost which permits mining of ground too low grade to be economically worked by the smaller boats.

The acme of California dredge construction and practice is exemplified in the monster Natomas No. 10 dredge of the Natomas Consolidated of California, which was placed in action in the fall of 1912. The hull is composed directly of steel and displaces about 450 tons, being nearly 300,000 pounds lighter than wooden hulls of identical type. It has a length of 150 feet, with a breadth of slightly over 58 feet, exclusive of the overhanging five-foot decks on each side of the craft. The 90 buckets are arranged in a close-connected line, and easily excavates 12,000 cubic yards per day under rather difficult conditions. This dredge is mining gravel to a depth of 55 feet in the refractory deposit of Rebel Hill. Nine motors developing 1,072 horsepower, are required to actuate the pounderous machinery. High-carbon and manganese steel was used in building the equipment whenever this high-grade material could be advantageously employed. The steel hull is expected to out-wear nearly two like constructions of wood, while the initial cost was about the same as if wood was employed. Growing scarcity of desirable timbers have seriously handicapped builders of the larger California dredges in past years, and replacement of wooden by steel hulls meets sev ral enigmas generated by the growth of the industry.

ALASKAN DREDGE MINING.

Alaska dredge operators have been compelled to solve special questions, generated by the naturally adverse conditions under which work was necessarily conducted. The heavy transportation costs in the far North, add necessity of shipping costly coal and oil for fuel to distant points militates against dredging of all but rich ground in many localities, while thawing of frozen ground and maintenance of sufficient heat on the boats to keep water flowing and machinery from becoming clogged with ice forms items of expense not experienced in more favored climes. For years it was thought that the frozen condition of much of the ground in Alaska, Yukon Territory and other arctic fields would prevent the development of a profitable dredging industry. Most of the early attempts were ignominious failures, and it was not until boats specifically constructed to meet the trying requirements were installed that the reluctant placers yielded golden reward. At the present time gold-dredging is one of the most important industries in the North, the gold boats of Seward Peninsula alone yielding in excess of $1,700,000 per annum. Besides the other obstacles with which they have to contend, Northern operators are hampered by the short season. It is generally deemed poor policy to attempt dredging until the spring frost has been thawed out by the rays of the sun, and most companies make no attempt at commencement of work before June 15. Early in the fall work is suspended in time to permit the men to embark on the last boat bound for the south. Attempts have been made to operate for

Close View of Business End of Natomas No. 10 Dredge in Action.

longer periods, but the great difficulties attending working of frozen ground has generally decided against the practice.

When it is imperative that the ground be thawed by artifical means, a boiler and steam points are impressed into service. The boiler generally ranges from 25 to 50 horsepower, with 15 to 20 points employed. The points are simply iron pipes, pointed at the bottom to facilitate driving into the hard soil. soil. The points are driven down a few feet and steam introduced from the boiler. The heat thus formed slowly thaws the round and permits the dredge buckets to dig the material. The thawing is done with little difficulty to a depth of eight feet, but as additional depth is required, the work becomes constantly more arduous and costly. It has been asserted that ground has been thawed and dredged to a depth of 50 feet in Alaska, but that this has been done on a permanently successful scale is denied by Northern operators. Thawing ground to depths of six and eight feet, with fuel costs fairly moderate, means an expenditure of approximately 20 cents per cubic yard. Several companies in the Yukon thaw and dredge gravel to a depth ranging from 15 to 25 feet, the cost depending on the extent f frozen material, and degree of hardness. It is evident that the adverse conditions under which Northern operators work militates against handling of any but high grade gravel, as the operating costs are vastly in excess of the rates prevailing in California and other southern districts.

Dredges in the North range from boats of the smallest type to the 16-cubic foot monsters of the Canadian Klondyke Mining Co. Many of the machines are provided with steam heating appliances, which are placed in close proximity to all parts requiring protection from the intense cold. Not infrequently operations are carried on with the temperature more than 20 degrees below zero, but with hot water and steam, operations are conducted with about the same ease as prevails in warm weather. High cost of fuel has ever been a factor reacting against low operating charges, and operators have constantly endeavored to cut down this expensive factor. During the past year several companies discarded coal in favor of the more economical crude oil, while other operators have evinced a tendency toward the gas engine when installations were situated at a considerable distance from supports. Under favorable conditions, Yukon and Alaska dredges handle gravel at a total cost of 12 and 13 cents per cubic yard—the record comparing favorably with operations in other fields, where the high power and fuel costs are taken into consideration. California type dredges are largely used in the North, with most of the boats constructed by leading American builders. Aside from solving the complex enigmas attendant upon dredging under such unfriendly conditions, the operators of Alaska and the Yukon have demonstrated that the modern bucket-elevator dredge is capable of wide application, and can be profitably employed under circumstances and handicaps that a few years ago were considered prohibitive for economical work.

TROPICAL REGION DREDGING.

Sharply contrasting with conditions in the frigid wastes of the Arctic are the problems that confront the dredge operator in tropical regions. Here dense undergrowth forms a formidable barrier to the advance of the gold boats, and demon-like insects make existence a missery for all concerned. The fiendish pests not only attack men, but direct their assaults upon the wooden hulls of the dredge, and in a few months ruin the staunchest craft ever launched.

Sudden floods must also be guarded against, with many other factors forcing constant consideration. The first move is the clearing away of the dense tropical growth on the deposit, and to resist the attacks of the wood-eating insects steel hulls are employed. It has been thought that roots of tropical growths in the deposits would seriously interfere with dredging, but with boats of latest design little difficulty has been experienced from this source. Of course, the presence of numerous roots, tree trunks and boulders naturally inpedes work to some extent, but it has been demonstrated in Columbia, British Guiana, Philippine Islands and other tropical fields that such impediments are not prohibitive bars to successful mining The constant danger of floods have led operators to locate their dredges a short distance inland, and in this way minimize the damage following sudden high water. Operations in the past have been handicapped by employment of small and inefficient dredges, but a more progressive spirit is being displayed, and many of the newer installations embody the latest advantages developed by years of practice in other fields.

Before the installation of a dredge is decided on in any field, the character of the deposit should be conclusively known. This can only be accomplished by systematic examination of the ground. While drills are largely employed in this work, the most satisfactory method is incontestibly the prospect-shaft, whereby the average value of ground and structure of deposit is known beyond all question. A high gold content does not always mean the ground is a desirable dredging proposition, as many other factors may militate against successful operations. It has too often been the practice to build the dredge first and prospect afterwards, and because of this many promising installations have been complete failures. Comprehensive prospecting is expensive, but the building of a useless dredge is even more so. When Hammon and Evans became interest in the possibilities of the Yuba River field, California, they proceeded to thoroughly test the extensive acreage before venturing upon the building of a single boat, despite the highly promising indications The period of prospecting consumed about two years, during which time over 300 drill holes and prospect shafts were sent down. It meant the expenditure of nearly $100,000, but the engineers were enabled to plan the type of boat that would be the most successful in this particular case. As the cost of a modern California-type dredge ranges from $50,000 for the small desings to $225,000 and $300,000 for the largest boats, it is evident that comprehensive and intelligent preliminary prospecting is essential, even though it may be attended with considerable expense. For the information thus gathered may mean the saving of thousands of dollars for the investors in the enterprise.

MINE VALUATION BY THE PUBLIC

By HEATH STEELE.*

Judging from market quotations on mining stocks, the public either does not care about the real investment value of a mining security or else is wholly lacking in knowledge of the fundamentals of mine valuation. No one should expect the average buyer of mining stocks to be an expert at appraisal, but there is such a great difference displayed in the ability to appraise mining and industrial same basis. To anyone who understands mining, this is ridiculous, as a railroad is at least supposed to maintain it assets, if not actually increae them, while a mine is naturally worth more at the beginning of dividends and depreciates thereafter rapidly in value So much has been published in the technical and financial press of late on the valuation of mines that it is reasonable to sup-

	12-Year Period, 1901-1912.				1912.	
Non-dividend-paying stocks.	Low record.	Date......	High record	Date......	Low record.	High record
Adventure	$0.625	1904	$ 33.00	1901	$ 5.00	$ 11.25
Allouez	1.75	1901	121.00	1907	35.00	50.25
Arizona Com.	0.10	1911	52.00	1906	2.00	6.87
Centennial	8.00	1911	47.00	1907	15.50	27.50
East Butte	3.50	1908	18.25	1907	12.25	16.78
Franklin	5.50	1911	29.25	1907	6.75	16.50
Giroux Con.	2.37	1907	10.50	1907	3.12	6.37
Hancock	3.25	1908	38.00	1909	22.00	37.00
Helvetia	0.70	1912	7.50	1909	0.70	1.12
Isle Royale	5.25	1903	56.50	1901	20.75	37.25
Keweenaw	0.50	1911	23.25	1905	0.99	2.62
Lake	4.00	1907	94.50	1910	22.75	49.00
La Salle	3.00	1911	35.00	1907	4.50	8.00
Mass Con.	2.25	1908	37.62	1901	5.00	9.00
New Arcadian	0.25	1904	24.75	1901	2.00	6.25
Superior	7.00	1907	68.25	1910	24.00	48.87
Trinity	2.87	1911	42.25	1907	4.00	9.50
Victoria	1.00	1911	12.00	1901	1.75	5.87
Winona	1.00	1902	15.25	1905	3.12	7.75
Wyandotte	0.10	1907	3.75	1910	1.00	3.25
Dividend-paying stocks.						
Anaconda	$ 15.37	1904	$ 74.00	1906	$ 34.50	$ 48.00
Ahmeek	45.00	1907	370.00	1912	240.00	370.00
Calumet and Arizona	45.00	1911	198.00	1907	57.50	83.50
Calumet and Hecla	360.00	1911	1000.00	1907	405.00	615.00
Copper Range	34.00	1901	105.00	1907	48.50	66.50
Tamarack	20.00	1911	363.00	1901	26.00	51.00
*Granby Con.	20.00	1910	151.00	1907	33.00	77.75
Greene-Cananea	5.25	1907	26.00	1906	7.37	11.12
Mohawk	22.00	1901	96.50	1907	50.25	73.00
Nevada Con.	6.25	1907	30.00	1909	18.25	24.62
North Butte	18.50	1910	120.00	1907	22.75	39.50
Old Dominion	5.00	1903	64.00	1912	44.00	64.00
Osceola	43.50	1903	181.00	1907	100.00	130.50
Parrot S. & C.	7.87	1911	58.50	1901	12.75	14.50
Quincy	55.00	1911	187.00	1907	72.50	95.00
Shannon	3.50	1904	24.37	1907	9.00	17.87
Tennessee	9.12	1901	55.50	1907	35.12	46.75
Utah Con.	9.50	1912	79.00	1907	9.50	20.50
Utah Copper	13.00	1907	67.37	1912	52.50	67.37
Wolverine	42.00	1902	200.00	1907	65.00	117.00

*New stock.

stocks that one cannot help wondering if the gambling element does not trade more in these stocks than in the other forms of securities. Some time ago I had occasion to look up the interest returns on mining and railroad stocks based on the average market quotations, and was surprised to find the public was buying both stocks on about the pose the public is more enlightened on the subject. I am inclined to think this is true, as the recent high prices do not show the overvaluations of 1906 and 1907, but there is still a lot of educational work to be done along this line.

The table given herewith shows the high and low records of 40 copper stocks for a 12-year period, 1901 to 1912. Of these mines, 20 have paid dividends and 20 are non-dividend payers.

* Mining Engineer, New York, in Mining & Scientific Press, March 8, 1913.

A RECORD OF PRICES.

It will be noticed that practically all the high records were made about 1907, when the price of copper was high. The non-dividend payers serve to show how the hopes and expectations of the public rise and fall, and the enormous prices paid for prospects. For example, basing the calculation on the present outstanding stock, this group of mines were given a market valuation by the high quotations, of $125,392,000, but when optimism gave way to pessimism, as recorded by the lowest quotations, the public's opinion of these mines depreciated $114,-439,000 and the appraisal was only $10,-953,000 for the group. Some may say this occurred over a long period in which many things happened; that some of these properties looked promising enough at one time or another to warrant a high valuation. But can there be any sound reason for the public's hopes fluctuating 90% in 1912? The record shows the low 1912 valuation of these non-dividend payers to have been $29,423,000 and the high selling prices to have added $26,430,000 to this amount, giving a total valuation of $55,853,000 to the same mines. It is not the valuation of $125,000,000 that staggers one so much as what the public expected of these properties when it placed that valuation upon them. For if a 15-cent average price for copper, and an 11.5c. cost be allowed, which is a very fair cost for these properties, and only a 6% average annual dividend be asked, it would mean that each should produce about 10,700,000 lb. copper per year for 41 years, or a total of almost 9,000,000,-000 lb., figuring interest at 5% on the investment. This would mean practically another Lake Superior district. If these mines be appraised at the average between the high and low quotations of 1912, the valuation would mean the successful development of about five mines out of this group. If the low cost of 9.5c. per pound on 15c. copper be allowed, it would mean a total production of about 400,000,000 lb. each in 41 years, figuring on a 6% annual dividend. The production of the Quincy mine, which has paid dividends for over 41 years, has been about 500,000,000 pounds.

DIVIDEND PAYING MINES.

Studies of the dividend payers yield figures that give good evidence of the public's erratic appraisals. The high quotations yield a vaulation of about $1,-063,000,000 placed on these mines, or 366% over the low quotations, which give a valuation of $228,306,000. In 1912 the public appraised these same mines from $465,747,000 to $659,359,000, a difference of 41.4% over the low valuations. These mines have paid approximately $217,000,000 in dividends during this period, or an average of about $18,100,-000 per year. If the valuation of $1,063,-000,000 placed upon this group be taken, the result figures to 1.71% income. The average annual dividend for the last six years has been $23,367,000, or 2.2% income; on the basis of 1912 dividends, $34,322,000, the return would be 3.2%. This is all that is necessary to say for this valuation.

Based on the lowest valuation, $228,-000,000, the average rate of income for the 12-year period has been 7.95%, and for the past 6 years 10.1%. On the basis of 7.95% income, with interest at 5%, would mean an expected life of about 21 years for these mines, and on a 10% income a 15-year life. The high valuation of 1912 with an annual dividend of $18,100,000 would give an income of 2.75%; on the 6-year average of $23,-367,000 the income would be 3.5%, and at the 1912 dividend-rate, 5.2%. This means that these mines would practically have to last forever and pay at the rate of 1912 dividends, which is about 17% higher than previous years, if bought at the high valuation on a 5% interest basis. On the low 1912 valuation, $465,747,000, the rate of interest return on the 12-year average dividend is about 3.9%, on the 6-year average dividend 5.05%, and at the 1912 rate about 7.46 per cent.

MINES ARE OVERVALUED.

As the majority of these stocks must have been traded at prices between the high and low average of the two 1912 valuations, $562,000,000 may be taken as indicating the real valuation placed upon these mines by the public. On this the interest return would be 4.15 and 6.12% respectively for the 6-year average and the 1912 dividends. If dividends will equal the 1912 rate for about 40 years, this valuation will be justified. It is evident from these facts that mines as a whole are consistently over-valued by the market quotations. However, one can very often point to undervaluations in the case of single mines, particularly those operating along sound business lines—not agitating with printer's ink and concentrating (the public's attention) with printing presses.

USE OF EXPLOSIVES IN THE TROPICS

By CHARLES S. HURTER.*

While it is the intention of the writer in this article to cover the use of explosives in tropical countries, it is also necessary to discuss in considerable detail points that are of great importance in regard to the proper use of explosives on all kinds of work, in any latitude. The beneficial results of strong detonators and good tamping are of the utmost importance. Also the careful attention that must be given to the storage of explosives in tropical countries cannot be overlooked.

Guttmann divides explosives into two classes, namely, low explosives and high explosives. Low explosives are those which can be made to develop their full force by direct means, such as simple ignition. The principal explosive in this class is blasting powder. Practically all the sporting and ordnance powders belong to the low explosive class. High explosives are that class of explosives that require an intermediate agent, such as a fulminate detonator, to cause them to develop their full explosive force.

There is one exception to this method of classifying explosives. Fulminate of mercury, and mixtures with this as a base, such as are commonly used in blasting caps and electric fuses or detonators, together with nitrogen iodide, silver oxallate, nitrogen sulphide and other explosive freaks, have the action of high explosives, but develop their full force upon simple ignition. A large number of authorities place them in a third class called fulminating explosives.

The action of blasting powder on exploding is that of a very rapid process of oxidation. As a contrast to this, the action of high explosives consists principally of a simple dissociation of compounds, followed by an oxidizing action, such as the reaction between the oxygen excess present when nitroglycerine is detonated and the compounds placed in the absorbent or "dope" of dynamite to take up this excess and secure the so-called "balance of formula."

Another classification shows low explosives to be mechanical mixtures, such as blasting powder; while high explosives can be regarded as chemical compounds.

In the low explosive class, the action takes place by means of the reaction of the particles composing the different

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substances in the mixture upon each other, the explosion being propagated from one group of such particles to the next and so on throughout the entire mass. An explosion so produced is necessarily relatively slow. A shock, unless of such extreme violence as to produce friction, will not explode blasting powder.

The case is different with high explosives. Here the elements that make up the explosive compounds are combined into definite molecules of uniform composition, held together by a relatively feeble chemical attraction. A shock will overcome the bonds which hold these elements together upon which they are free at once to react upon each other, producing gases at a high temperature, the result being an explosive effect. An explosive wave is thus generated, which is continued throughout the entire mass. Thus perfect combustion is accomplished in an infinitely small space of time and an effect of particular violence is obtained, which has been called "detonation."

MANUFACTURE OF DYNAMITE.

The high explosives or dynamites used for blasting in the United States are divided into three classes, commonly known as nitroglycerin dynamite, extra or ammonia dynamite and gelatin dynamite.

The first dynamite that appeared on the market was composed of 75 per cent nitroglycerin and 25 per cent of an infusorial earth called kieselguhr. The kieselguhr being an inactive substance consumes some of the strength of the nitroglycerin and detracts from its sensitiveness. The result is that the 75 per cent kieselguhr dynamite is only about as strong as the American 40 per cent, and kieselguhr dynamite containing less than 40 per cent of nitroglycerin cannot be exploded by ordinary means.

Another of the earliest absorbents used for nitroglycerin was sawdust. It was from this that the American dynamites of the present day were evolved. Theoretically, when nitroglycerin is detonated, five per cent of the gases given off is free oxygen. The dope of the dynamite is made up largely of wood pulp and either sodium or potassium nitrate in proportions to make a complete balance of the chemical reactions which take place on detonation. Dynamite made in this manner may contain as low as 12½ per cent or as high as 75 per cent of nitroglycerin and constitutes what is known at the present time as the nitroglycerin dynamites.

The series of nitroglycerin dynamites constitute also the standard series against which all other explosives are compared, and contain or should contain the actual proportion of nitroglycerin that is given as their "percentage strength."

One of the characteristics of the nitroglycerin dynamites is their very quick and shattering action. This quickness increases with their strength. The water resisting qualities of the nitroglycerin dynamites are better in the higher than in the lower grades. The fumes from the nitroglycerin dynamites are the poorest of the three classes of dynamite, the lower grades giving off less deleterious gases than the higher. The nitroglycerin dynamites are all very easily ignited by flame or sparks such as might issue from the sides of defective or the cheaper grades of fuse. Therefore, considerable care must be used in the making and placing of primers when using nitroglycerin dynamite for blasting.

By replacing part of the nitroglycerin with nitrate of ammonia a series of explosives having strengths similar to those of the nitroglycerin dynamites are obtained, called extra dynamites. This class of explosives has distinguishing characteritics that make them very valuable for certain kinds of work.

As the extra dynamites contain less nitroglycerin than the corresponding grades of Nitroglycerin dynamite, they have a somewhat slower action. The fumes are very much superior to those of the nitroglycerin dynamites. They are the most difficult of any of the ordinary high explosives to ignite. It is practically an impossibility to ignite extra dynamite from the side spit of any kind of fuse or even if the end of a length of fuse is inserted in the cartridge without a blasting cap.

The water resisting qualities of extra dynamites are not so good as those of the nitroglycerin dynamites, but this difference can be almost entirely overcome by dipping the cartridges in melted paraffine after filling. The sensitiveness of extra dynamites is less than that of the nitroglycerin dynamite, and therefore nothing less than a No. 6 detonator should be used to explode them.

In the course of the experiments made by the late Alfred Nobel with explosive compounds, he found that he could dissolve some of the lower grades of guncotton in nitroglycerin, forming a waterproof explosive jelly that was slightly stronger than the pure nitroglycerin itself. This jelly is the base of the present blasting gelatin, gelatin dynamite and gelignite. The gelatin dynamites have a relatively slow, heaving effect when exploded by No. 6 detonators, but when detonated by a primer of strong nitroglycerin dynamite or of blasting gelatin, they have more of a quick, smashing action than the corresponding grades of nitroglycerin dynamite. Still, when fired by means of a No. 6 detonator, the more effective load, due to the density and plasticity of the gelatin dynamites, more than counterbalances the deficiency in quickness when compared with the corresponding strength of nitroglycerin dynamite.

These gelatins are the densest of the high explosives, which fact makes them very valuable for tight blasting where a concentrated charge is desired at the bottom of the bore holes. The fumes are superior to those from both the nitroglycerin and extra dynamites. Being very nearly waterproof in the lower and perfectly waterproof in the higher grades, the gelatins are best adapted for use in extremely wet work and submarine blasting.

DYNAMITE IN TROPICAL CLIMES.

In only the very dry sections of the tropics can all of the explosives of the temperate zones be used with success. While the extra dynamites are the greatest favorites in the United States, there are very few places in the tropics where they will not be spoiled by the climate in a relatively short time.

The E. I. du Pont de Nemours Powder Company has made a special study of explosives for use in tropical countries, and as a result the du Pont gelignite has become one of the standard dynamites for export trade. This belongs to the gelatin class, but has a few changes in its ingredients to improve its keeping qualities under severe conditions of transportation and storage.

Along the northern edge of the tropics, as in Mexico and Cuba, with a few exceptions the same explosives and style of cases can be used as in the United States, because the closeness of the market to the source of supply makes long storage unnecessary.

The excessive heat and humidity of the tropical rainy seasons places a very serious problem before the manufacturers of explosives. A very large number of explosives that will not remain in good condition if exposed for any length of time to a tropical climate have become great favorites in the Temperate Zones. Also the making a climate proof explosive often narrows the range and cuts down some of the more desirable features of explosives that can be used under better conditions. Where the transportation conditions are not too severe and where the injury to cases in shipment is a minimum, special air tight packages can be used that, when handled carefully, will keep any standard explosive in good condition for an indefinite time.

The gelignites are dense, fumeless and nearly waterproof. Their strengths are rated according to their actual nitroglyc-

erin contents, viz.: 34 per cent, 42 per cent, 51 per cent and 62 per cent, which correspond to the 40 per cent, 50 per sent, 60 per cent and 75 per cent strength gelatin dynamites of the United States. They are very plastic, giving a very effective load for tight blasting and they stick well in uppers.

For latitudes nearer the equator the greatest care must be taken to protect the explosives from the effects of the climate during shipment and storage. The cartridges are all dipped in paraffine after filling in order to make them airtight. The cartridges are then packed in cartons, each carton containing five pounds net weight of explosives. Ten cartons are packed in each case, which is made of heavier wood than those used for domestic shipments. For extra protection the cartons have an airtight bag to hold the cartridges, or the cases have a double lining of special waterproof paper.

In these countries extra dynamites cannot be used unless shipped quickly and not allowed to remain any length of time in storage.

It is in these places that the gelignites have given the best results. Their composition is such as to enable them to remain in good condition in the heat and humidity of the tropics longer than any other explosives.

Blasting powder is very effective for large blasts in open work. It has a slow, heaving action that is well suited for shaking up large quantities of material. Blasting powder is made in two series, one using nitrate of potash or India nitre and the other nitrate of soda or Chili nitre, as oxidizing agents. The potash powders withstand the effect of moisture a little better than the soda powders, being a little slower than the potash, have a better spreading and heaving effect.

The keeping qualities of both powders depend mostly on the tightness of their container. The standard steel keg holding twenty-five pounds net weight of powder, is rough and careless. Most manufacturers have special airtight packages for blast powder, which they furnish at reasonable charges to cover the extra cost of packing.

The use of blasting powder is naturally confined to dry work, as it is instantly ruined by contact with water. In the United States it is manufactured in hard and soft grains, both of which may be glazed or unglazed. On account of the ease with which the soft grain and unglazed powders absorb moisture, hardly anything is used but the hard grain glazed powders. The principal features of this latter variety are its density and the bright polish of the grains. It runs freely into down holes and packs well in place, forming a very effective load for heavy blasting. The best method of firing large blasts of blasting powder is to use dynamite primers with electric fuses placed in the center of the charge. This kind of a primer insures ignition at the center of the charge, and the large flame on ignition insures a more violent action from the powder than would be the case if exploded by only the spit of ordinary fuse. Also the ground will be broken up in better shape if a line of holes is fired at one time in this manner by electricity.

In practice, detonation is accomplished by means of an intermediate agent that will produce both shock and heat. The relative amounts of shock and heat depend on the composition of the detonator charge.

DETONATORS AND REACTIONS.

Fulminate of mercury is the compound which forms the basis of all detonator charges. According to Berthelot, this is the most powerful detonator. This is to say, the shock from fulminate of mercury is quicker and more violent than that of any other substance used for producing detonation. This is explained by the suddenness of its decomposition, together with the extraordinary magnitude of the pressure which it would develop when detonating in its own volume.

In regard to the phenomenon of detonation, the action which takes place depends more or less on the strength of the initial pressures, on the suddenness of their development and the relative stability of the compounds used to make up the explosive, which, in turn, regulates the ease of the communication of the shock to the rest of the mass. That is to say, the action which takes place de-up the explosive, which, in turn, regulates the energy transformed into heat in a given time on the first layers of the explosive substance reached by shock.

The quantity of energy thus transformed depends, therefore, both on the suddenness of the shock and the amount of work it is capable of performing.

Mixtures of fulminate of mercury with other compounds are made with the object of increasing the amount of heat liberated and thus the pressure of the gases formed. The compound most commonly used for this purpose is chlorate of potash. The decomposition of chlorate of potash into potassium chloride, and oxygen liberates a certain amount of heat, and the conversion of carbon monoxide into carbon dioxide generates a great deal of heat. On the other hand, this oxidation being a secondary reaction, the shock is not quite so sharp, but as detonation can be caused by heat as well as by shock, it is possible to use mixtures where the great gain in heat more than counterbalances any deadening of the shock.

According to this reaction, 245.2 parts by weight of chlorate of potash must be mixed with 852.12 parts of fulminate of mercury to bring about complete combustion. Roughly, this proportion can be expressed as 2 parts of chlorate to 7 parts of fulminate. The mixtures in use vary from 80 per cent fulminate and 20 per cent potassium chlorate to 95 per cent fulminate and 5 per cent of chlorate of potash, the idea being to get a mixture in which the heat developed will give the greatest assistance in producing detonation without deadening the initial shock of the fulminate.

METHODS OF STORING.

One of the greatest causes of trouble in the use of explosives in tropical countries is improper storage. In the heat and humidity of the tropics the construction of proper magazines is of even far more importance than in the temperate zones. It is fairly common to find magazines for the storage of explosives with a damp dirt floor and no provision for ventilation. In some of the almost airtight magazines that the writer has visited in the tropics, the temperature has been all the way from 120 to 130 degrees Fahrenheit. If more attention were paid to the proper storage of explosives, a great deal less trouble would be experienced by the consumers.

The E. I. du Pont de Nemours Powder Company has taken the lead in trying to remedy this trouble, by sending its customers, free of charge, on request, complete plans and specifications of magazines to store any quantities of explosives.

It is of the utmost importance that magazines should be dry and well ventilated. If the ventilation is not good the temperature is liable to be high enough to cause even gelatins and gelignites to leak. The ventilation should be under the floor as well as through the interior of the building. The air current under the building not only aids materially in keeping the temperature down, but keeps the floor dry.

The packages of explosives from the principal manufacturers have their trademarks as well as "THIS SIDE UP" on the tops of all cases of high explosives, by having the cases with the top side up, the tendency for the nitroglycerin to collect at the lower end and possibly leak from the cartridges is entirely obviated, as the cartridges are all lying on their sides. The tendency for leakage of the liquid contents, if the cartridges are stored on end, is more pronounced at high temperatures, so it is of the utmost importance in tropical countries for high

explosives to be stored with the cartridges lying flat.

In the storage of blasting powder, it has been found that there is less possibility for the entrance of moisture if the kegs are placed on end, bung down. For a long time it was customary to stack them on their sides, but careful observations over a long term of years by the E. I. du Pont de Nemours Powder Company has shown conclusively that when the kegs are kept on end, bung down, the powder will remain in good condition for a much longer period of time.

In the building of magazines, the Spanish-American countries seem to prefer thick stone or adobe walls, with another one surrounding it. While this forms an excellent protection against bullets or other outside causes of accidental explosion, these walls are immediately converted into thousands of missiles, which are thrown broadcast over the country if an explosion occurs.

Two courses of soft brick (nine-inch wall) laid in cement mortar, are sufficient to stop a steel-jacketed bullet fired from a modern high-power military rifle. The mortar should be laid as thin and compactly as possible, to exclude even the most minute air spaces. By using soft brick, if an accidental explosion takes place, the walls are instantly converted into dust and there are no missiles. Instead of stone or adobe walls surrounding the magazine, earth embankments form just as good protection and will not become dangerous projectiles in case of accidental explosion.

Magazines can be bullet proofed by putting a wooden lining inside the walls and filling the space between it and the outside wall with coarse, dry sand. When smokeless powder is used in high-power military rifles it takes eleven inches of dry sand to absolutely bullet proof a magazine, but with the 30-30 Winchester or equivalent, which is the strongest rifle in common local use, eight inches of dry sand is sufficient.

USE OF DETONATORS.

Another great cause of poor results in blasting is the use of weak detonators. For years the South and Central American countries have been used as a dumping ground, by European manufacturers, for weak blasting caps and electric fuses. In their own countries the use of anything weaker than a No. 6 detonator is prohibited by law, yet they seem to think that anything is good enough for Spanish-America. The cheaper price of weak detonators appeals to many, but the difference in price between one of them and a No. 6 detonator, which is only a fraction of a cent, may mean the difference between a good and a bad blast. It takes only a very few bad blasts to more than cover the difference in cost between a year's supply of weak detonators and strong ones.

Berthelot, the greatest authority on explosives, states as follows:

"The reaction induced by a given shock in an explosive substance is propagated with a rapidity which depends on the intensity of this shock, because the energy of the first shock transformed into heat determines the intensity of the first explosion and consequentl the intensity of the entire series of consecutive effects. The more violent the initial shock the more sudden will be the induced decomposition, and the greater the pressure generated during the entire course of decomposition."

In short Berthelot claims that the action of any explosive is stronger when fired by means of a high-power detonator than with a weak one. Bichel and Guttmann also make the same recommendation.

During the last few years the manufacturers of explosives have paid great attention to the safety features as regards the handling of their products. The result is that the explosives on the market at the present time are not as sensitive as the dynamite sold a few years ago. This has resutled in a great reduction in the annual number of accidents in the handling and use of explosives, but it also makes the use of strong detonators of more importance than it was four or five years ago.

The use of a strong detonator in a large number of cases also overcomes possible trouble due to improper or careless charging of explosives. Also if the strong detonators have not been stored properly they can resist a greater quantity of moisture without becoming useless than can the weaker ones. Actual analyses of gases after blasting underground have shown the presence of smaller amounts of bad fumes when strong detonators are used. Some of the poisonous gases formed by improperly detonated explosives are odorless, so the sense of smell alone cannot be relied upon to prove or disprove the presence of bad fumes after blasting. In the United States a large number of mining companies, after careful experiments and tests, now use only No. 8 detonators, which are twice as strong as the No. 6. Spanish America has been a dumping ground long enough, and all users of explosives should insist on being furnished with nothing weaker than No. 6 blasting caps or electric fuses. The charge of a No. 6 detonator consists of one gram (15.43 grains) of the standard fulminate mixture.

Almost everywhere there is considerable discussion in regard to the use of tamping. Some claim that tamping is entirely useless; a very large number say that enough to make the hole airtight is sufficient, and a few still believe that by tamping the hole solid to the col lar the best results are obtained. The last idea corresponds to the writer's opinion.

When an explosive substance is detonated in its own volume, the maximum of temperature and pressure, and consequently the maximum speed of the chemical reaction involved, is attained; that is, the total heat possible to develop in the reaction is obtained at the instant that the energy of the explosion is exerted on the surrounding medium.

MANUFACTURE OF FUSE.

During the past five years there has been a wonderful improvement in the manufacture of fuse. The use of a cord winding has largely replaced the tape. The fuse made in this manner (countered fuse) has become a great favorite over the tape varieties. It is more flexible, less liable to break or crack when bent sharply, and has the same water-resisting qualities as the corresponding grade of tape fuse. In the eastern and central sections of the United States, the Crescent brand, manufactured by the Ensign-Bickford Company, has largely replaced the doubletape fuse. The countered fuses are much cleaner to handle, and will not stick together in the coils during hot weather like the tape fuses.

In conclusion, the writer recommends for use in tropical countries the gelignites, which are the best water-resisting explosives on the market. They rarely leak nitroglycerin on long storage or when exposed to excessive heat and humidity, as often happens with explosives containing nitroglycerin in a liquid state.

The utmost care should be taken to have the proper storage conditions for explosives in the tropics, as a very large amount of trouble can be traced directly to faulty magazines. Strong detonators should always be used. The advantages of these are shown very emphatically by the work done in hard rock and the better fumes in close places. The larger companies who specialize in the manufacture of explosives for use in the tropics should be consulted in case of trouble, as they are generally in a position to offer sound advice.

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Salt Lake is becoming the "City of Apologists." When our friends visit us from other states and cities we find ourselves apologizing for the smoke, and for the loss of the beautiful city views and mountain panoramas that we used to own

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Copper production of Canada in 1912 was 33,000 long tons.

Mines and Methods

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CONTENTS:

"Spieler" for the "Commercial Club" excursion to Bingham: "Ladies and gentlemen: We have now arrived at the 'greatest copper camp on earth.' On your right is the workings of the Utah Copper Company. You came here, no doubt, expecting to see how the steam shovels operate on the 'ore,' 'near ore' and 'waste' that is mined and hauled to the mills of the company at Garfield and converted largely into tailings. Were it not for this high board fence and the army of 'fighting deputy sheriffs' which guard the gates and all approaches to the property for fear that a representative of Mines and Methods might slip through, we should be glad to have you all see this magnificent, shimmering mountain of copper ore in all its splendor and dazzling brilliancy of color; but, for the reason stated, you will have to content yourselves with whatever peek through the knot-holes of the fence you may be able to obtain unobserved by the deputies. Then we shall get ready for the return trip."

The Pending Crisis In Utah Copper

For several months past the subsidized press of the Utah Copper Company have made frequent comment on the fact that the Nevada Consolidated Company has, in the working of larger quantities of low-grade ore, demonstrated that a good profit can be made on ores containing no more than one per cent copper. In fact it was said that ores containing as low as eight-tenths of one per cent copper had been treated at a profit by that company. These facts were also mentioned by Manager Jackling with the evident intent of impressing the public with the perfection of the methods and processes by which ores are mined and treated at the several properties under his management, and also, to avoid any shock which might result from his late announcement that upon the properties of the Utah Company, it has been found that a large portion of material which had theretofore been regarded as capping, and which contained one per cent copper and less had, during the period covered by the last quarterly report, been sent to the mills and treated with satisfactory results. In fact, the report showed that the entire tonnage of ore sent to the mill for the period covered, contained barely one per cent copper.

We have already shown how the tonnage of the Utah Copper has been increased from time to time by including in the estimates neglected quantities of comparatively barren rock, and how, to afford justification for the continued use of steam shovels, the stripping on Boston-Utah ground, which had become of a thickness of some two hundred feet, and therefore impossible of economical stripping, had been in the later estimates of ore reserves, sliced off from the bottom and added to the vast sum of three hundred million tons of ore theretofore reported But, with all their juggling with facts and conditions, the Utah management, through its press, has deftly contrived to make it appear that the large bodies of high-grade ores, of which so much was said in earlier reports, still remain untouched and to be drawn upon at convenience when these low-grade rocks shall have been disposed of, thereby affording easy access to the high-grade reserves which are to be drawn upon for dividends when market conditions shall justify pegging the price of Utah shares at a higher level.

But the cold facts are that, as frequently shown by this journal, the higher grade ores have from the first been drawn upon by underground burrowing until every available vestige of such ores has disappeared; the result being—as must have been noted by all readers of Utah reports—a persistent dimunition in the copper content of the rock treated, until the best of that remaining, of which there is doubtless a very large volume, contains barely one per cent, or twenty pounds of copper per ton, and that overlain by some 200 feet of absolutely worthless rock which must be removed if the steam shovel folly is to be continued. Of course, as we have also previously shown with respect to the high grade ores, no possible profit can possibly be derived from the mining and treatment of ores of this grade by the Utah company, if its former methods are to be continued. Whenever the real facts shall have been exposed it will be shown that for the past six months there has been an actual loss of at least two and a half cents upon every pound of copper produced by the Utah company.

It was given out by the manager and the press that from a short time prior to the first of March operations had reached the normal production of 20,000 tons per day, or 620,000 tons for the month of March; in fact, it has been said that as much as 25,000 tons per day was handled for a portion of the month, it being understood at all times that a sufficient excess over the tonnage reported—to cover the moisture, depreciation and metallic contents—is always included, if not understood.

Reports just received from the eastern offices show that the production of copper in concentrates for the month of March was a little over eight million pounds which, divided by the tonnage treated, gives a gross yield of about thirteen pounds per ton of ore as compared to a yield of about twenty-one pounds as shown by the annual report for the year 1911—a deficit in the production for the

month of March, this year, of about eight pounds of copper per ton of ore—and in value, about $1.20 per ton. The reputed net yield from all sources for the Utah plant for the year 1911 shows an apparent profit of about 90 cents per ton of ore treated, all of which, with an addition of thirty cents a ton, would have been wiped out had the yield of copper been thirteen pounds per ton for the month of March instead of twenty-one pounds as reported for the year 1911, or a direct loss in addition to all the ore treated of thirty cents per ton, being $186,000 for the month.

When we come to consider that notwithstanding the purported large earnings and payment of dividends during previous years, when operating upon a higher grade ore, the company is now struggling with a floating debt of some $8,000,000, what must be the condition of the company's exchequer if present methods and conditions be continued a few years longer, we leave to the conjecture of shareholders.

We are quite willing to concede that the result of operations on low grade ores by the Nevada Consolidated, as reported, are perfectly feasible and credible, but conditions and the direct management at the Nevada Consolidated—the operations of its mines and mills—are very different from those that obtain at the Utah plant, and that ores of the Utah containing even eight-tenths of one per cent, with honest and intelligent methods of mining and treatment, and with copper at thirteen or fourteen cents a pound, should afford a fair margin of profit.

And now that the immediate burden of operating this vast property has, by the retirement of Manager Jackling, fallen upon the shoulders of Assistant-manager Gemmel, and in view of the fact that all efforts to market the shares by deceptive methods have failed, the paramount question now is, will Mr. Gemmel be permitted to meet the situation man-fashion, and adopt at once intelligent and sane methods of mining and treatment of these vast bodies of misrepresented, but yet commercially valuable ores.

Speaking for Mr. Gemmel personally, we do not hesitate to say that if he fails in this crisis, it will not be because he does not know the only and better way, for he is not only a capable and practical engineer, but, withal, a conscientious and intelligent gentleman.

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In a descriptive article on the mines and prospects of Mason Valley we read that "this vein is a fissure in gray, crystalized lime, which constitutes the hanging wall." Good.

THE TARIFF ON LEAD

Our friends of the Commercial Club have permitted themselves to be lashed into a high state of frenzy by a number of well-meaning but grossly misguided and misused gentlemen, who have come to believe that the lead and precious metal-mining industries are greatly imperiled by the reduction in the tariff on lead, proposed by the pending Democratic tariff-revision measure. We beg our friends to possess their souls in patience and to consider in a broad light, and practical sense, what would be the possible and real effect upon these great industries should this measure actually become a law, as in all human probability it will notwithstanding the most strenuous efforts of our friends to the contrary.

The bill provides a duty of half a cent a pound upon the lead contents of ores imported into the United States, which a moment's consideration, we think, will afford ample protection against any possible importation of ores of that character, as any lead brought in in this form would necessarily be involved in a cost of at least one cent a pound before it could be put in condition to compete in the market with lead in pigs and bars. Besides, with no lead coming from British Columbia, and a premium in that country upon its production, and with smelting plants in Mexico which take care of all the production of that region, anything in the form of pigs or any possible importation of stray lots of lead ore may at once be dismissed as negligible in quantity.

In the matter of the importation of lead in pigs and bars, the bill provides an ad valorem tax of twenty-five per cent which, in view of the fact that for years the price of lead had been maintained in this country practically at and above four cents a pound, it will be seen at a glance that the duty would be at least one cent per pound and more; so that no foreign lead could be marketed at less than five cents per pound and to which, of course, must be added costs of transportation, commission, and so forth. Of course, if the price should rise higher in this country, the ratio of the tax would increase proportionately.

Now, in view of the fact that the difference between the price of lead in bars between this and foreign markets has for years ranged at and above one-half cent per pound, and was, during the latter part of last year, and January of this year, one-half cent a pound higher in London than in New York; and in view of the further fact that all lead producers in foreign regions have been greatly depleted, it certainly seems that the proposed rate would afford ample protection to our home producers. In this connection it may be pertinent to observe that the paramount peril to the lead-mining industry of the United States, and the world abroad for that matter, lies in the absolute control of the lead production of the United States and Mexico by the Guggenheims, through the National Lead Company, or lead trust.

It will be remembered that about the time of the meeting of the last Congress, and as notice to their country as to what would happen if there should be any interference by Congress with the tariff on lead, Mr. Daniel Guggenheim, head of the lead trust, from a clear industrial sky, announced a cut of thirty cents per hundred pounds on lead which he followed up by further cuts amounting in all to about sixty cents per hundred pounds, which brought the price in New York to a point about fifty cents below the market in London. If our friends will direct their attention to an investigation of the lead trust, and of the American Smelting & Refining Company, their efforts will have some show of bearing fruit advantageous to the industry they are seeking to conserve.

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J. C. Dick, a local mining engineer formerly in the employ of the Utah Copper Company, returned from a trip to the properties of the Alaska Gold Mines Company a few days ago, and the newspapers were glad to get an expression from such a "disinterested" source. Mr. Dick was quoted as saying that he found conditions even better than has been reported. He found the ledge to be all of 300 feet wide, instead of the seventy feet originally claimed and he also reported that they were getting ore in the Sheep Creek tunnel, also. This would indicate that the "vein" is all of 6300 feet wide instead of 300 and it will aid materially in the tacking on of several hundred million tons of newly developed ore when the management gets ready to make another try to filch a few million dollars from the public. Mr. Dick is a pretty busy man and it was good of him to go up and undertake to clear up the situation and breathe new life into the corpse. But it won't work, Jim! We even doubt if the Guggenheim vultures will attempt to feed on that carcass.

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It is now about a month and half since the Commercial Club decided to undertake a solution of the smoke and fume problem and appointed a special committee for that purpose. If anything has happened since we have not heard of it. The newspapers—beg pardon—the daily press seem to have forgotten all about the "official" investigation demanded a few weeks ago. What's the matter?

Federal Mining Report Shows Up Guggenheims

The report of operations of Federal Mining and Smelting company for the first six months of the present fiscal year (September 1, 1912 to February 28, 1913) signed by its secretary, Mr. Frank Sweeny, and sent to the stockholders, merely emphasizes the extent of the continuous loss sustained by stockholders through its contract with the American Smelting and Refining Company which minority interests are now seeking to annul as fraudulent and which was made when the Federal Company was, as it still is, controlled by the smelting company and when the latter company was in fact both contracting parties.

Assuming the figures in the report are correct and that production has been maintained at last year's average of approximately 10,000 tons of ore and concentrates a month, containing an average, as last year, of 42% lead, it is evident that about 22,680 tons of lead have been produced in six months after allowing usual deduction of 10% for "smelting loss" The average price of lead from September 1, 1912 to February 28, 1913 was $4.614 per 100 lbs. or 23c higher than the average quoted in the company's last annual report.

This does not agree with the statement in the Secretary's report that "earnings were made in spite of the prevailing low price of lead." The report also fails to mention that the average price of silver for the same period was 62.881c per ounce, as compared with 58c recorded in the last annual report. This would account for added earnings of approximately 95c per ton of ore, or roughly $9,500 per month.

But, instead of receiving the price for lead above quoted, the Federal Company, under provisions of its smelting contract, only received $3.94, or 67c per 100 lbs less than the average price of lead, or no less than $5.06 per ton on ore and concentrates shipped. This means that on 60,000 tons produced in the six months covered by the report, the controlling trust has paid for the product shipped it by the Federal Company over $300,000 less than its market value, in addition to taking a smelting charge of $8 per ton, amounting to $480,000. Other producers in the vicinity of the Federal Company enjoy a freight rate to smelting points as low as $6 a ton, but Federal is, by the terms of the contract, to pay a of $7.15 for the privilege of doing business with the Guggenheims, although the greater portion of the product is shipped to a point where the freight is $2.75 per ton.

Summed up, if Federal enjoyed such a contract as that granted by the same trust to the Hercules Mine (controlled by the family of Harry L. Day, president and general manager of Federal, who also draws a salary of $15,000 from stockholders) its six months' earnings would have been $892,600, instead of $520, 000 as reported by Secretary Sweeny. This is at the rate of $1,785,-200 a year, or 10% on preferred stock and a surplus of $585,200. Put in another way, if Federal received full value for its lead product, its honest earnings would provide full 7% dividends on its $12,000,000 preferred stock, full 10% on its $6,000,000 common stock and still leave a surplus of $345,000. This does not take into account the juggling of freight rates.

The world's visible supply of lead is running short and there is no question in the mind of any man acquainted with the real situation that, tariff or no tariff, the price will advance materially in the next few years, although it may be artificially depressed for a time by the Guggenheim interests using the bugaboo of the reduction of the tariff for that purpose.

Remembering that this unholy Federal contract has still seventeen years to run, stockholders can easily figure for themselves the extent of the iniquity practiced by the American Smelting and Refining Company, the controlling interest, and the enormous amount of which they will have been deprived at the end of the contract period. Their money is now being used to insure this result. They can also understand the tremendous importance of this contract in its bearing upon the trust's domination of the lead market of the United States.

SIDNEY NORMAN,
On behalf of minority stockholders

In addition to depicting clearly the tremendous losses that the shareholders of the Federal Mining and Smelting Company must sustain for the next seventeen years if the present smelting contract is not annulled, Mr. Norman's letter makes reference to another matter that it would be well for those who predicting dire disaster in case the tariff on lead is removed by Congress, to think about. The Federal Mining Company is one of the largest lead producers in this country and it is certain that Mr. Norman, as a stockholder in that company, would not make the statement he does above if he thought for a moment there was danger of ruining the lead-producing business by tariff revision, other than through artificial depression of the price by the Guggenheims for political effect. Backed by such outrageous contracts as that being enforced against the Federal Mining Company, the lead smelting trust—tne Guggenheims—can well afford to spend some money in playing the political end of the game for the temporary effect it may have, because the producer is made to "pay the freight" anyhow.

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BREAKING THE CAPPING

If steam shovel mining is to be continued at the Utah Copper, we beg to call the attention of the new manager, R. C. Gemmel, to a statement found in Mr. Jackling's report dated January 24, 1908, page 14, in which he says: "THERE ARE SOME ADVANTAGES IN CONTINUING UNDERGROUND MINING OPERATIONS IN SOME PORTIONS OF THE PROPERTY, BECAUSE THE ORE MINED IN THIS WAY IS TAKEN FROM THE OREBODIES LYING DIRECTLY BENEATH THE CAPPING, RESULTING IN THE CAPPING CAVING INTO THE OPEN STOPES AND BREAKING ITSELF, SO THAT IT IS NOT NECESSARY TO BLAST IT FOR STEAM SHOVELING"

The great advantage of the method mentioned by Mr. Jackling (in that it avoids the very great expense which would otherwise be involved in the drilling, and blasting the capping with powder) will doubtless be apparent to Manager Gemmel. We simply call the attention of Mr. Gemmel to ex-Manager Jackling's wise method of breaking down capping in order to justify the suggestion that, inasmuch as the ore has been—by underground mining methods—entirely removed from the property on the east side of the canyon, and the caving in and breaking up of the capping in that entire area having been completed, rendering it in the highest degree susceptible of removal by steam shovels, that the shovels now operating on the west side of the canyon, preparatory to securing ore, (and which work is attended with great expense in breaking down capping by blasting) be removed to the east side where the ground already is prepared in a manner to afford the advantages in steam shoveling

contemplated in the statement of Manager Jackling. In the meantime, underground working could be pushed on the west side until the capping there would be compelled to break itself in the open stopes, preparatory to future steam shovel mining operations.

SWAMPED BY TAILINGS

When locating the proposed site for the great Garfield-Magna, Utah Copper, concentrating plants, the ground was visited by the directors and others interested in the property and some mild criticism was offered by a member of the party concerning the flat character of the ground selected by Mr. Jackling, on which the proposed structure was to be erected. Vice-president Wall suggested that the mill be placed on the side of the mountain, one or two hundred feet higher, in order to secure the advantage of gravity in handling the ores through the mill, and also to insure ample dump room for the deposition of the enormous quantity of tailings which would result from the treatment of the ores of the great deposit, and to which Mr. Jackling replied: "I want to build my mill on level ground, and I would rather pump my tailings than pump my water." It now appears that the accumulation of tailings has been such as to already encroach upon the railroad used for removing the concentrates from the plant, and they even threaten to engulf the lower floors of the mill. To avoid this calamity it appears that large quantities of stripping material is being hauled from the mines, over the Bingham & Garfield Railroad, and dumped so as to form a levee, or dyke, between the mill and the railroad tracks, and thus check the encroachment of the tailings. In this connection we beg to suggest to Manager Gemmel that he adopt the wise suggestion of Manager Jackling and at once install a series of units of sand pumps in order to turn the tide of tailings in the direction of Great Salt Lake. We recommend that the units be so placed as to permit the addition of other units as the capacity of the mill may be enlarged to meet the ever-increasing volume of ore at the mines.

CHINO DIVIDEND IN PARIS

It is little wonder that the Frenchmen have recently been hurling back to America the Chino shares they were inveigled into buying in the belief that the company was on a dividend-paying basis. The scheme worked upon them was, according to the following, from the New York Times Annalist of Monday, April 14, a fine example of sharp practice—to be charitable in expression—and it illustrates perfectly to what extent the company's sponsers in this country will go in order to find a market on which to unload. Just think of a company representing itself as being on a dividend basis abroad months ahead of the time when it begins PROMISING to pay at home. But let the Annalist explain to you how the "shell game" has been manipulated:

On Feb. 10 The Annalist printed in its Paris cable a statement to the effect that the Chino Copper Company was expected either to reduce or discontinue the dividend on its stock. This, the Paris correspondent said, was the reason for the weakness of the Chino shares on the Paris market that week.

Various adept writers on mining topics in New York and Boston made sport of this news, and asked if it could be true that neither the mining editor nor the Paris correspondent of The Annalist knew that Chino Copper stock never paid a dividend. The Boston News Bureau commented disagreeably upon what it assumed to be a journalistic blunder, said it was a brilliant example of going away from home to get the news, and indignantly called upon The Annalist to dismiss the misinformed Paris correspondent.

It will, therefore, be news to all of them that Chino Copper has been regarded in Paris as a dividend-paying stock from the beginning, has always been quoted as such on the Exchanges, and made at the outset a distribution which every one was led to call a dividend.

That is to say, on the introduction of Chino Copper to the Paris market the first buyers cashed a premium of 1.25 francs per five-dollar share. Thereafter the shares were officially quoted as "Coupon No. 1 stamped for installment dividend paid," or "Coupon No. 1 detached."

On March 3, which was nearly a month later than the Paris correspondent's cable to The Annalist, the following paragraph of information appeared in the financial columns of the Paris papers:

"The Directors of Chino Copper have postponed the declaration of their dividend. This step was rendered necessary by the inability of the company to meet the amount of the dividend coupon, having insufficient funds for that purpose, in consequence of having been unable to market its entire output of copper."

On March 20, Le Globe, in one of its financial paragraphs, called attention to the fact that a dividend rumor about Ray Copper had failed to affect the stocks favorably and surmised that people were too easily reminded of what had happened in Chino Copper, where, after having led every one to expect a dividend, the company deferred the payment thereon. Although the Chino shares dealt in in Paris and here are identical in every other respect, those dealt in in Paris were from the beginning referred to as dividend-paying shares. It was perhaps intended that they should be so regarded.

J. M. Bruce is the name of the man who has been sent out from the Missouri lead-zinc mines to take charge at the Butte & Superior and see what he can do with it. Eastern "financial" papers (spare the name) state that Mr. Bruce relieves Max Atwater—which he don't. He relieves Allan H. Rodgers, who is reported to have become so disgusted with the entire Utah Copper crowd and its methods of "cooking things up" that he could not, and would not, stand for it any longer. We do not know Mr. Bruce, but our heartfelt sympathies go out to him.

DALY WEST LEAD RECOVERIES

The Salt Lake Mining Review of March 30 contains the following editorial paragraph:

Mill Superintendent Sherman, of the Daly West Mining Company, operating in the Park City district of this State, reports that the actual saving in lead values for the past fiscal year was 98.7 per cent. To the best of our knowledge, this is a most unheard of recovery in the milling of lead ores, and has never been equaled or approached.

The writer's memory is either failing or else he has not paid much attention to the contents of Daly West annual reports. The record mentioned is so commonplace at the Daly West as to have long since ceased to cause even passing comment. In December, 1909, in an article dealing with the merging maneuvering of the Daly West company, we took occasion to show what a perfect master of the business of ore concentration Mr. Sherman was, and among other things said:

These statements show that at no time during a period of several years has the recovery of the lead contents of the ore fallen as low as 98% and seldom below 99½%. The mill superintendent's report for 1908, page 12, says: "The average assay value of the tailings was 0.02 of 1% Pb. (meaning lead), * * * while the actual saving, based on the value of the concentrates sold, was 99.8% of the Pb.," or lead contents of the ore.

To illustrate the extraordinary character of this work, the report states that "original contents of lead in the ore was 4.71%," equal to 94.2 lb. per ton of ore, of which 94.01 lb. were recovered, the loss being a little less than 0.19 of a pound, or about three ounces of lead per ton of ore treated—barely enough to supply a single charge of a shotgun.

And such statements as these have been annually handed to stockholders by the management for several years past. At the same time from three to five groups of men, averaging in all probably twelve men daily, working with the most crude appliances, have been constantly engaged collecting and rewashing the tailings as they flow down the canyon from the company's mill, and all are said to make wages ranging from $3 to $8 per man per day—and all this derived exclusively from a recovery of portions of the three ounces of lead per ton shown by the official reports of the company to have been lost in the concentration of its ores.

These results appear all the more remarkable when it is understood that when the company's mill was operated at full capacity the loss of lead (Pb. as the mill superintendent puts it) did not exceed 75 lb. per day, and worth, less standard deductions, about $1.60. From all of which it must be inferred that those technically untrained gleaners of the tail-race, with the primitive methods employed, have surpassed in efficiency the most modern appliances of the age—or that the management is indulging in coarse deception.

And we might add that the working over of the tailings from the creek below the mill is still (in season) carried on presumably just as profitably as ever. And it may be observed that one of the leasers during all this time,—and at the present,—has paid and continues to pay $50 per month for the privilege of operating his primitive machines upon lands owned by others, over a portion of which the tailings flow, after having been discharged from the company's mill. It may also be added that this operator is at the head of the line of the retreating plants.

Guggenheims Want $15,000,000 from Public

The announcement that the Guggenheims are preparing to offer the investing public an opportunity to supply the needed capital for the recently organized Chuquicamata Copper Company of Chile, S. A., is worthy of more than passing notice, inasmuch as the plan of financing the proposition is in strict keeping with the practice of these promoters in all similar projects with which they have had to do in the past.

The new company will absorb the mining properties formerly owned, and partially developed, by the Chilian Exploration Company. The capitalization of the new company is stated to be $110,000,000, divided into $25 shares. Of this capital stock $15,000,000 will be held for the conversion, at par, of a $15,000,000 convertible bond issue bearing interest at 7% annually. The remainder of the capital stock, $95,000,000, will be retained by the Guggenheims and affiliated interests. Only the convertible bond issue will be offered the investing public for subscription

This proposed $15,000,000 bond issue will afford the sponsors of the project a return of their original expenditure of $2,500,000, and, after setting aside the $7,000,000 said to be necessary for mill and other equipment purposes, will provide a cash reserve of $5,500,000. Thus it will be seen that the Guggenheims do not for a minute contemplate a direct investment for themselves. What they have accomplished in past instances is evidently proposed in the present flotation. The initial expenditure (absolutely in the nature of a temporary loan) of $2,500,000 was made only for the purpose of preparing the property for financing, and not as an investment. The main object throughout has been to exploit the property, then finance it with money furnished by the investing public (which financing would return the amount of the temporary expenditure, in adidtion to tremendous profits resulting from stock-market manipulations), and to retain control of the property without having directly invested a dollar. The plan proposed, if carefully studied, will make the matter clear.

To those conversant with the physical operation of large properties the capital requirements of even $15,000,000 which it is hoped the public will supply is excessive, considering the extent and operation of the property. To others, dealing exclusively in stock market matters, regardless of the ultimate liquidated value of the stock based upon physical operations of the mining property, the relative proportions of the stock issue retained by the promoters to that offered the investing public, clearly indicates the trend of affairs.

It is claimed by the promoters of the new Chuquicamata company that there has been developed to date, approximately 100,000,000 tons of copper ore having an average content per ton of 1.75 to 2.0 per ton copper. Although a considerable area of mineralized ground was partially developed by means of the earlier mine-workings, which have been a source of information to the engineers in charge of the development work, the aggregate ore exposures therein would represent but a fractional part of the total prospecting necessary to develop the tonnage of ore claimed by the promoters, inasmuch as the older workings were mainly superficial. Eliminating that factor in the development it will be interest to note that six Star traction-drills now have been in operation on the property for about a year churn-drilling the orebody. During the year's operations the drills have been actually operated only about fifty per cent of the time, due to climatic conditions and difficulty in drilling resulting from the peculiar structural relation of the rocks due to the extensive faulting. In view of these circumstances the declared development of 100,000,000 tons of ore in six months is questionable, as also is the claimed general average grade of the ore.

By the leaching process which it is understood the management intends to use in the tréatment of the Chuquicamata ores, it is claimed that a 90 per cent extarction of the copper content will be effected, but no statement of cost per pound of refined metal is given.

Regardless of whether a profit is made on the Chuquicamata operations or not, the Guggenheims will be fully recompensed, financially, for their efforts in promoting the new company. This will be accomplished in part, through the plan of financing the property as hereinbefore outlined, and later through arrangements that will tie up the Chuquicamata company in a smelting, refining, and selling contract Ample evidence along that line is available from the history of the Utah Copper, Chino Copper, Ray Consolidated, and more recently, (as outlined elsewhere in this issue by Mr. Sidney Norman, representing the minority stockholders) of the Federal Mining & Smelting Company, all of which have been tied up on long term smelting contracts affording the Guggenheim interests outrageous profits as compared with what might have been obtained in a competitive market.

Of course, in order to acquire these contracts it has been necessary at times for the Guggenheims to consider investments in the respective companies securities, but, relatively speaking, the term of contract together with the excessive charges imposed on the individual company under the agreement, permitted an ultimate capital return to the Guggenheims far in excess of the initial investment in company securities, which latter oftentimes were sold in the open market at a favorable profit, and in no instance at a loss. Therefore, it will be noted that investments in the securtities of other companies by the Guggenheims is merely a means to an end. Having secured a long-term refining and selling contract, an investment on their part directly in the mining or milling enterprise is unnecessary, for the very apparent reason that through holding that agreement, indirectly they control the proposition.

Aside from the other circumstances surrounding the control of the Chuquicamata project as hereinbefore noted, the probability is that the new plant will not produce refined electrolytic copper but rather a precipitate which will require refining at one of the Guggenheim smelteries—under a contract which will afford practically the entire profit of operations to them. When such an agreement is consummated (provided there shall be any product to treat) the Guggenheims then can withdraw from the company by gradually disposing of their share of the remaining $95,000,000 capital stock to the public, and still continue in control of the property, as theretofore, through the medium of the smelting and selling contract. Even though the property should succeed in maintaining operating expenses only, insofar as the mining and milling operations are concerned, the increment derived on the smelting, refining, and marketing of the product would amount to many millions of dollars during the life of the property.

Thus, assuming the ore tonnage developed (100,000,000), average copper conten (2.0% maximum), percentage recovery, (90%) and other managerial statements to be correct, then, if we should assume the treatment of 7,000 tons of ore daily as the capacity of the mill, and an allowance of ten per cent loss in smelting and refining, the life of the property would be forty years. During that period, on a copper metal production totaling 3,240,000,000 pounds, and allowing a minimum profit to the Guggenheims under their usual "contract" of 1.75 cents per pound of refined, market-

ed metal, their profit would represent $56,700,000, or at the rate of $1,417,500 annually. This amount, added to the sale of 50 per cent of the $95,000,000 of stock in the company that remains after bond conversion provisions, would afford a yield of $47,500,000, making a grand total rake-off of $104,200,000 for the Guggenheims, without a dollar's expenditure or one cent of risk on their part.

AN HONEST ANNUAL REPORT

The annual report of the Phelps-Dodge company for the year ended December 31st, 1912, made its appearance on the first of the present month. It is a model of concise, truthful information and as such we commend it to the mining and ore reduction companies which apparently strive as hard to deceive shareholders as this company does to let the world know just what it is doing. A careful perusal of the several balance sheets clearly illustrate the practice of the management in the presentation of facts. Each report is complete and in detail, so that the distribution of accounts is not difficult to follow. Of particular interest is the manner in which the management cares for the amortization of its several properties. Renewal funds are carried as they should be, and the annual depreciation on plants and mining properties is lucidly presented. The valuation placed upon the mining and reduction properties is evidently conservative, and at no point is there to be found any deviation from a conservative and straightforward policy of publicity.

The company owns important mercantile establishments at its various mining, milling, and smelting points. In these, primarily, the object sought is to afford employees an opportunity to purchase merchandise at a small profit over actual cost. This feature is best illustrated from the fact that, during the year 1912 the gross sales amounted to $6,321,410.86, on which a profit of but 9.12 per cent was earned.

During the year the quantity of copper delivered was 192 297,374 pounds, of which 98,267.037 pounds were sold to domestic, and 94,030,337 pounds to foreign trade. The average price realized on sales for the year was 15.51 cents a pound, net cash, f. o. b. New York.

On the basis of its issued capital of $45,000,000, dividends amounting to $6,750 000 were paid during the year, or at the rate of fifteen per cent for the year. This was occasioned by the payment of two extra dividends (one of 2 per cent at the end of June, and another of 3 per cent at the end of December) in addition to the usual quarterly dividend of 2.5 per cent. The financial statement also indicates a substantial reserve fund against stocks owned, as also a satisfactory surplus account.

The subsidiary companies of the Phelps-Dodge interests are: The Copper Queen Consolidated Mining Company, Detroit Mining Company of Arizona, Moctezuma Copper Company, Burro Mountain Copper Company, Stag Canon Fuel Company, and the Phelps, Dodge Mercantile Company.

During the year the total copper ore extracted from the company mines amounted to 1,983,244 tons of which quantity 1,098 528 tons were concentrated, and 794,716 tons smelted directly. The total amount of copper bearing material smelted, including ores, concentrates, old slag, and cement copper, amounted to 1,051,315 tons. In addition to the above there was produced, and sold, 11,626 tons of lead ore from the Copper Queen mines, yielding 30.434 pounds of copper, 2,953,685 pounds lead, 326,962 ounces silver, and 3,889 ounces gold. Of the total ores and concentrates smelted 953,741 tons were derived from the company properties and 97,574 tons were purchased.

The Copper Queen smelting department report, covering the operation of that department, states that there was treated on the entire plant, 1,151,949 tons of charge, of which 884,814 tons were smelting ore, 73,720 tons were silicious ore for the converters, and 193,415 tons composed of converter and furnace secondaries. The bullion produced was 124-915,708 pounds.

It is stated that a great reduction in the amount of flue dust was effected when the fumes from the converter were deflected from the cupola dust chambers, and a still greater reduction when the reverberatory plant started up, and the fines sent to that department. It dropped from a maximum of 8.87 per cent per ton of charge in the month of June to 2.72 per cent per ton of charge in the month of December.

In April, 1912, a change was made from the old acid process to the new basic process of converting matte. Two stands of the Great Falls type of basic lined converters were placed in commission toward the end of the year, and the remainder of the old-style barrel-shaped converters will be replaced by Great Falls type converters as soon as practicable.

The report of the Detroit Copper concentrator operations is outlined in the following table:

	Assaying % Copper
Ore concentrated, 501,928 tons...	3.08
Concentrates produced, 70,428 tons	16.69
Savings:	
Ore and concentrate...........	76.12
Ore and tailing...............	77.34
Concentrate and tailing........	77.06
Assays only	77.43
Tailing assay	0.811

Tons ore milled per ton concentrate	7.1 to 1.
Actual percentage running time to total time	95.11
Tons ore milled per 24 hours actual running time..............	1441.8
Gallons water used per ton ore milled	511.2

The detailed report given above is noteworthy for its brevity and correctness. For example, the methods employed in the calculation of the general average percentage recovery of copper mineral from the material is important. Note that the per cent variation between the highest stated average percentage recovery (77.43%) and the actual operating results (76.12%) affords a difference of less than 1.5 per cent. This method of determining the percentage recovery is commendable, and should be more generally employed by other large mills; in fact, it is the only correct means of determining absolute results, and precludes the padding of operating reports. Other equally important factors are the presentation of the facts governing the actual period of operation through the year, and the average daily tonnage for the year.

The Detroit smeltery blast furnace and converter operations show the treatment of 173,266.8 tons of material from which there was produced 24,802,789 pounds of copper bullion. The general average percentage recovery in smelting and converting for the year is stated as 93.863 per cent.

The mining fraternity generally will be glad to know that Prof. Chas. E. van Barneveld, has accepted appointment as chief of the department of mines and metallurgy of the Panama-Pacific International Exposition and that he will be at his desk, Exposition headquarters in San Francisco, on May 1. For the past fourteen years the professor has been at the head of the mining department of the Minnesota School of Mines. Previous to that he spent six years in general mining practice in Colorado, the Southwest, Mexico and Canada. The professor is a graduate of McGill University, Montreal, Canada, and enjoys a wide circle of friends in the mining and metallurgical world.

Copper production of Peru in 1912 was 27,400 long tons, as against 26,000 in 1911.

PASSING OF TWO NOTABLE CHARACTERS

Developments of Past Month Bring to Mind Recollections of Methods Employed to Create Booms and Manufacture Mining Engineers and Magnates.

During the closing hours of the stormy month of March, and within four days thereafter, the passing of two notable characters was announced. The first, Joseph T. Jenkins, for many years mining editor of the Salt Lake Tribune and the Intermountain-Republican, passed to the Great Beyond. Mr. Jenkins possessed signal ability as a newspaper writer, and had many traits of character which, had they been differently directed, would have made him an enviable name. But let us draw the mantle of charity over evidences of his short omings, and join with those who knew him, in saying: Poor "Joe;" peace to his ashes.

On the evening and night of the fourth day of April, following the event recorded above, the young "multi-millionaire" mining magnate, Daniel C. Jackling, whose portrait is presented at the head of this column, was guest of honor at a banquet given at the Alta Club for the purpose of celebrating the unparalleled success of his numerous exploitations, and to say "good-bye, Jack," on his retirement from this field of his former activities.

Before proceeding with further discussion of the operations of this brilliant young millionaire in this and neighboring fields let us revert to the earlier history of speculative manipulation which resulted from the impluse given by the facile pen of the late Mining Editor Jenkins; because it was to his persistent energies along the chosen line that the eminent engineering skill, and managerial ability, attributed to Mr. Jackling, as well as the success of the various enterprises with which his name was connected, was due almost wholly to the efforts of Mr. Jenkins And yet withal, we are advised that he was permitted to die in comparative poverty. In order to show how the speculative appetite of communities involving vast financial interests was worked up—in which Mr. Jenkins played a leading role—we can do no better than reproduce the following article from the Bingham Bulletin of Friday, February 24th, 1905:

There was a time, and not very long ago, when the mining columns of the Salt Lake Tribune were confidently and eagerly searched each morning for the latest and most reliable information upon all matters pertaining to the new life upon which the mining industry had then just entered. The accidental discovery by the Wilman brothers, of a large body of lead ores upon the old and long-abandoned "Tenderfoot" claim, near Park City, had led to the development of the enormous bodies of rich silver-lead ores of the Mayflower and Silver King. "Old Camp Floyd," after a slumber of more than twenty years since the closing of Sparrow-Hawk mine and mill by Captain Shaw and the English owners, had suddenly been aroused to new life by the discovery of gold in paying quantities in the carboniferous shales that extend over vast areas of that district, and which for a time promised to rival in extent and richness the "Rand" of South Africa, with which it was compared in many material characteristics; likewise the old camp of Ophir, whose low grade ores had slept for even a longer period of time, was, by the application of modern skill and improved methods, in the midst of a season of unprecedented prosperity. At Tintic the "Grand Central" and the "Uncle Sam" had suddenly burst into prominence by reason of discoveries of large bodies of high grade ores, in hitherto undeveloped portions of that erstwhile quiet camp. Even the lease-worn camp of Bingham had experienced a new birth, due to the accidental discovery of vast bodies of copper sulphides in the Highland Boy mine, following the usual disappointments which result from efforts to extract gold from rocks wherein none is contained.

The slump in the silver market and incidental paralysis of dependent industries due, in large measure, to the hostile attitude of the last Cleveland administration, had driven the restless miners to search anew abandoned "stopes" which marked the former hiding place of valuable ore bodies, and to pursue to greater depth the faded evidences of pre-existing wealth, with the result that every old "camp" could now boast of one or more old mines rejuvenated and many new and promising discoveries made in hitherto undeveloped grounds. The precious metal contents in many instances was found to be in diminished proportion, and base and refractory substances had intruded instead, but improvement in metallurgical knowledge and mechanical skill had kept pace with emergency. Meanwhile the people had acquired habits of economy and thrift and many had laid by hordes of comfortable proportions, and were eagerly looking forward to some favorable opportunity of investment which promised quick and profitable returns.

A great "mining boom" was on in earnest and the air was laden with reports of reputed great strikes. Dreams of sudden wealth haunted every household. A mining and stock exchange became the necessity of the hour, that the widow's mite, the banker's horde, and the gambler's "wad" might have ready opportunity to invest in the representatives of the new-born wealth. Then it was that the Genius who presided over the mining news of the daily paper became and was a real autocrat. He stood between the investor and the vendor, and by coloring or distorting the facts, had it in his power to make or dissipate the hope and fortune of either with the stroke of his pen. How important was it then that this department of the daily paper should be administered by a capable, conscientious and honest person.

The Salt Lake Tribune, having always been the friend and organ of the mining industry, easily maintained the lead as the dispenser of what was believed to be the latest and most reliable news in all that pertained to that field of enterprise.

New corporations, holding out glittering promises, sprang into existence with bewildering frequency until the list upon the daily call-board of the Salt Lake Mining and Stock Exchange numbered nearly one hundred. True, but few of the producing mines were included in the list. The real value of their shares was too high for the purse of the small investor, who demanded a large number of shares for a small sum of money. They argued that the producing mine had sprung from a prospect hole and all remembered when the shares of the Silver King were almost as cheap as the meanest on the list. Then why not all those become great mines also? And this thought received daily encouragement not only from the promoters of various wildcat schemes, but from the daily press, and especially the Salt Lake Tribune, whose mining columns teemed with fabulous stories of "strikes" upon claims which had never felt the impress of the miner's pick, and of promised early dividends from others upon which not a pound of marketable ore was ever known to exist. And thus was the public appetite whetted from day to day; speculation was at fever heat; transactions upon the stock exchange reaching scores of thousands was of daily occurrence. Meanwhile the real mines continued to pour the result of their riches into the public lap, which made it all the more easy to maintain the delusive speculative interest in the "wildcats." And this condition continued with little abatement of interest for some three years, during which time probably two millions of dollars were drawn from the meagre earnings of clerks, servants, teachers, laborers, and small merchants, and dumped into the stock market in exchange for shares that never possessed intrinsic merit equal to the value of the pulp of which the paper was composed. And all this made possible chiefly through abuse of the power and prestige of the Salt Lake Tribune by the trusted editor of its mining columns.

Did this editor profit by the waste of other people's money which he caused? "It is said" that he did to the extent of at least $40,000; but, "it is also said," that finding accumulations too slow, he entered the brokerage firm of Higginbotham & Company in order that he might be in position to anticipate advances in the share market which were sure to follow the publication of manufactured falsehoods pretending to disclose inside news of daily "strikes" in the "matchless" Tomcat mines.

But, "it is further said" that the scheme proved unprofitable, in fact, disastrous, for it appears that the active members of the firm had not been let into the secret (whereby "strikes" seemed to be always on tap, just at the proper moment, to enable the firm to make clever turn

before less favored brokers could "catch on,") and therefore they were naturally disposed to regard as serious, everything which appeared in the Tribune. Thus it happened, "it is said," one fateful morning that a "manuscript" recording a phenomenally rich strike in the "Peerless Tomcat," and designed as a "double header" for the mining columns of the Tribune the following morning, had been left on the desk of the versatile partner in the back room of the office where it was prepared. The Tribune appeared as usual, but contained no news of the "stupendous" strike in the sky levels of the Master Tomcat mine. In fact, there was no mining news whatever that morning. The voluble editor-partner failed to appear at the usual hour. Of course, he must be sick; he was not very strong at best and was subject to sudden attacks which frequently caused his absence for days and sometimes weeks, but he always came back smiling and there was no cause to fear this time. But how fortunate that the public had not caught on to news of the strike, thus reasoned the remaining member of the firm of Higginbotham. Then they went forth and loaded up with the shares of the Tomcat mine until the firm's entire cash balance was exhausted, and then some more; but this was a fatal error. The public never learned of the "strike" and therefore, refused to buy the shares of the famous feline; thereupon the firm failed and "it is said" the strike editor of the Tribune dropped his "wad," whatever that may mean.

In the progress of time the more wealthy class of people became infected with the speculative stock-gambling craze, so that there was demand for higher class securities, and transactions involving large blocks of shares in dividend paying mines were of frequent daily occurrence. But the want was not "long felt." The Uncle Sam mine at Tintic which had produced several hundred thousand dollars worth of valuable ore under the individual ownership of "Uncle Jesse" Knight, was for sale on the "quiet." True, it was not producing at that time, because, as the sequel showed, it had been gutted of every ton of known marketable ore. But this fact was not known, or suspected, by the stock-buying public; besides, "Uncle Jesse" was a peculiarly eccentric man and had often been heard to say, when asked why he did not continue to mine and market the vast bodies of rich ore therein exposed, "that the money was safer in the mine than in the banks, and as he was not in immediate need of money he preferred to keep the mine closed."

Having secured the necessary authority, Hon. Dave Evans opened subscriptions to shares in the "Uncle Sam Mining Company," a corporation to be formed which would take over the Uncle Sam mine. There were to be 500,000 shares, and the subscription price was one dollar per share. Only a selected few were let into the deal at first, and in an incredibly short time it was announced that the shares had been over subscribed many thousands; whereupon the Tribune began an incessant fusillade of falsehoods, picturing in nauseous terms "stupendous ore reserves" which only awaited the magic touch of the new corporations to convert them into immediate dividends. And thus, even before the new shares could be printed, the price had been forced above $2.00 per share, so eager were the investors to secure a small holding in this bewitching venture. Ten thousand shares had been discreetly placed at the disposal of the Tribune staff, of which 6,000 shares were retained by Mr. Lannan, 1,000 was awarded to———, and the remaining 3,000 shares to the editor of the mining department of the paper. J. S. Daveler, foreman of the printing department, was ignored in the division of the spoils, and therefore "gave the snap" away.

The success of this fraud prepared the way for the perpetration of another, even more glaring, along the same lines, and so the "Carisa," another worked out bonanza, was put out with the same number of shares, subscription price, $1.25 per share. This was likewise over subscribed, whereupon the price advanced to $1.60 before the shares were delivered. The Tribune's efforts to secure higher prices having been even more vigorous than in the cause of the Uncle Sam, and it is said the mining editor's allotment consisted of a like number of shares. Then came another companion piece and neighbor, the "Yankee,' the career of which was phenomenal. Within the space of a few weeks its shares had been rushed from about ten cents, which was too high, to over $5.00, the mining editor being credited with a net profit—for his "influence"—of over $10,000. The "Chloride Point," near Mercur, under the chaperonage of "Parson" Tibbals, with the promise of early dividends, persistently urged by the Tribune, found ready sale at $1.30 per share upon a capitalization of 400,000 shares. This proved a dumping ground for the savings of the teachers in the various public schools, and even ministers of the gospel are said to have yielded to the temptation to get rich quick. The intrinsic value of these shares was never a measurable quantity.

By the same methods the Northern Light, adjoining the Chloride Point, with 400,000 shares, had been pushed from nothing, its true value, to $1.50 per share. The "Daisy," worth nothing, to 65 cents at and near which price the whole bunch of 300,000 shares were unloaded upon the public. The list of worthless stuff located at various points throughout the state might be extended indefinitely, but space and time forbids. One special case we have in mind, however, should not be passed over. It is the California mine, near Park City. This property was being developed in a vigorous and systematic manner, and for a time gave promise of real merit; but the owners apparently became tired of the long wait for legitimate results and so determined to reach the goal by a short cut. The services of the Tribune were enlisted and soon a substantial boom in the share market was an accomplished fact. The price of shares rapidly advanced from a few cents to nearly $3.00 per share. Upon a morning following a certain day on which the highest recorded price of sales on the exchange was $1.45, the Tribune announced the purchase at private sale by McCornick of 15,000 shares of California stock at $1.75 per share, or thirty cents a share above the market. Of course, there was not a word of truth in the statement, but it had the desired effect. The market price almost immediately passed the $1.75 point supposed to have been set by McCornick.

At this juncture poor old Ben Sprenger, an ex-member of the Exchange, planked down $1,750 in gold in exchange for 1,000 shares of California stock. The mystery in the transaction was, where did he get the money? for he was known to have been broke for months. The last $2,000 he possessed he had given to his invalid wife for safe keeping lest it be lost in wild speculation as other thousands had before. But there was nothing strange in the matter after all. Having read in the Tribune of the latest strike, and how McCornick was buying the shares without regard to price, it was easy to convince his sick wife that great profit would result from investment of the "sick fund" in California shares, and so it was done.

Mrs. Sprenger died soon after, but not until she had seen the price of California quoted at less than ten cents. Poor soul, she seemed to lose interest in life, and her strength failed rapidly after those precious gold pieces had been carried to the dumping ground. As to the mining editor, he has not been well, either, of late, but occasionally returns to his post long enough to announce some of the more important strikes made in the numerous properties of the United States Mining Company, and to examine the market list so as to be prepared to realize on those 400 shares in case the price should at any time exceed $26.50 per share.

Following the publication of the foregoing article Mr. Jenkins was retired from the service of the Tribune. But soon thereafter, on the establishment of the Intermountain-Republican, he was given full charge of the mining department of that paper.

About this time, Charles M. MacNeill, and others, in whose employ Mr. Jackling was then engaged as foreman of their smelting enterprises in the State of Colorado, secured control of the property which thereafter became known as the Utah Copper Company's mines at Bingham, of which Mr. Jackling was made manager. Up to this time Mr. Jackling had had no technical training, or practical experience in the operation of mines of any character, nor in the treatment of ores by any process, other than that of smelting, (which he gained during his Colorado employment) and of roasting ores preparatory to the application of the leaching process while in the employ of Capt. J. R. De Lamar, under the management of Mr. H. A. Cohen, at Mercur in this state.

The negotiations for the sale of the control of the property to MacNeill and others were conducted by Mr. Cohen under an option held from the then owner, in which negotiations he was materially assisted by Mr. Jackling, who then, as now, because of his genial social qualities, was held in high esteem by Mr. McNeill and associates. For this service Mr. Cohen's commission, amounting to about twenty-five thousand shares of Utah Copper stock, was divided equally with Mr. Jackling in addition to which the former owner, Col. Wall, added in cash $5,000.

Now it appears that Mr. Jenkins, for some reason, was not friendly to Col. Wall, and that some time after the exploitation of the property began under Mr Jackling, relations between Wall and Jackling became somewhat strained, because of Wall's disapproval of Jackling's method of equipping and operating the mine. This, together with Jenkins' well-known propensity to magnify and laud everything done by each incoming new mine captain, afforded ample excuse for the exercise of his accustomed journalistic methods to at once begin the task of making a great mine magnate of Manager Jackling, and at the same time discrediting and disparaging the presumptions of Col. Wall—who was yet the largest individual owner in the property—wherein he had from time to time expressed disagreement with the manager's operating methods. This, of course, was assumed to be pleasing to Mr. Jackling; at least, it resulted in special consideration being awarded at all times to Mr. Jenkins. And so the work of building up a great engineer and a great mine began, and so it continued from day to day, ad nauseum, until the columns of the mining department of the Intermountain-Republican teemed with effusive utterances magnifying every blundering movement and act of the manager in his abortive attempts to develop and equip the mines.

Mr. Jenkins had been frequently heard to remark jocularly that during his newspaper experience in Colorado he had made some sixty odd colonels of men

of all grades of character and avocation, who had accidentally or otherwise, been the recipients of any considearble sums of money, derived from mine strikes or the sale of stocks. Of course the same tactics were pursued in his journalistic work in this case, where the crop of military-titled gentlemen, whose promotion was also due to the pen of Mr. Jenkins, was very considerable. Prominent among these earlier operators were Colonel O. P. Posey, Colonel E. C. Loose and Colonel Samuel Samuel Newhouse, whose photographs together with fulsome and extravagant comments upon his many achievements, including the notorious promotion of the Newhouse Mines, before its final slump, almost daily cumbered the columns of the mining department of the Intermountain-Republican.

One of the first reportorial acts of Mr. Jenkins after the installation of Mr. Jackling as manager of the Utah Copper mines, was to confer upon him the favored distinction of Colonel. Following this the development of the Utah properties by new and startling methods and the construction of reduction plants of stupendous proportions at once became the marvel of the mining age, whilst the advancement of manager Jackling to the highest pinnacle of enginering skill and ability was swift and dazzling; in fact, he became a veritable mascotte. The ores upon which this fabric was based were new to the engineer, as well as the ordinary mine operator and miner. The copper tenor of the rock was low, while the quantity was inexhaustible; but nothing short of magic could convert the contents of this strange ore into a commercial product. And although many thousands of dollars had been expended on this property in the driving of drifts, all in ore, and in the testing out along well-known lines of economical and practical methods the best process for the recovery of its valuable contents—and the publication of these facts in technical and other journals—the result of which was the convincing element which induced the Colorado capitalists to invest their money therein, no mention was ever made of former exploitations or knowledge even of the existence of these remarkable ores in the publicity campaign which had been thus inaugurated. In order that the acts of this new champion of engineering miracles might not be dimmed by the works of others, the great mass of new-born earth was simply referred to as the Bingham porphyries, and this, together with the masterful acts of the manager, was followed by such persistence and frequency that the speculative mining world was made to almost believe that the genesis of the rock mass itself was the handiwork of Manager Jackling.

The scramble for the shares of the corporation which ensued soon caused the price to reach dazzling heights. Attracted by the prowess of this wonderful genius, and the commercial possibilities that underlaid the scheme, the Guggenheims were not slow in securing a controlling interest therein, together with a contract for smelting the product of the mines for a period of twenty-five years, and at a rate of three dollars per ton in excess of that ordinarily charged for treating such ores at that time, being equal to an additional profit of nearly one cent a pound on all copper produced. They were enabled to secure this very favorable contract because of the fact that Mr. MacNeill, and the other promoters of the enterprise, had become convinced, upon the advice and persuasion of Manager Jackling, that the property could never be operated in such manner as to produce any legitimate profit, and that they must look to the marketing of shares for future benefits. This conclusion seemed to be justified by the fact that, prior to the advent of the Guggenheims, the Copperton mill, which had a capacity of about 700 tons per day, had been constructed and in actual operation upon the selected ores from the property for about seven months, the results of which were such as to confirm the conclusions of Manager Jackling that all hope of a working profit was futile, the cost of copper produced thereby being in excess of fifteen cents per pound.

In the light of this demonstration the manager had disposed of practically all of his share holdings, much of it at a very low figure, 6,500 shares being given in exchange for a house and lot on Brigham street in this city, worth, at the time, and now, not over $18,000. But the Colorado capitalists were adepts at promotion, and for such purposes knew the value of association with the Guggenheims at that time. It was easy, therefore, for these shrewd practical operators to sense the fact that at least operating costs could be drawn from the ores and thus the smelting contract would become a valuable asset of the family. The purchase, however, was coupled with a loan of $3,000,000, secured by bonds convertible into shares of the company at $20. A further condition of the smelting contract, however, was consent to an agreement that Mr. Jackling would be retained at will as manager of the company. This they readily acceded to, because of the market value of his remarkable reputation as a construction and mining engineer which had been built up by the press, as before indicated.

It may be here observed that the touch of the Guggenheims in connection with the flotation of any mining enterprise was, at that time, magical, so much so that no question was asked by intending purchasers, as to the intrinsic merit of the shares of any corporation with which their names were associated; and it was, and still is, their habit to buy a block of shares in a corporation which controls a meritorious property in order, first, to secure a favorable smelting contract, and then dispose of their purchase to incoming investors attracted by their association therewith. In this manner was secured the extortionate smelting contract with the Federal Mining & Smelting company complained of in a letter published elsewhere in this issue by Sydney Norman. In like manner, and for like purposes, and undoubtedly upon equally exhorbitant rates, were contracts secured by the Guggenheims for the treatment of the Ray and Chino mines, by purchase of large blocks of the shares of these companies.

Because of the exclusive experience of Manager Jackling in the development, and treatment, of these new-born ores, and of the eminence he had attained as an engineer, it was an easy task to rejuvenate the old Ray Con. and Chino mines, and to secure from the public all needed financial help without impairing, or imperiling the majority holdings of the promoters. All that was necessary then was the co-operation of Manager Jackling, by his selection as vice-president and general manager of these properties.

In order to create a proper appetite for these securities Manager Jackling was delegated to distribute a number of shares in these properties among influential followers, including reporters, and attaches of various newspapers, and in other channels of publicity. These distributions, however, did not involve the actual delivery of the shares, because that might disturb market manipulation, but simply a brief note stating that the holder was entitled to a certain number of shares at a stated price—which, in the case of Chino, was $5—the shares to be sold or taken over by Manager Jackling on the order of the recipient, and the difference between the price stated and the market value to be paid over to the holder of the option. No payment of any sum was required for the privilege of the option, the idea being that it was the desire of the manager to confer a personal favor upon the party, and that the stock was being carried without cost to him—Jackling.

The popularity which these issues and the parent Utah Copper attained in the manner stated is well known to every one who has followed the mining share

market. Hayden, Stone & Company, and other brokers, discerning the market value of Manager Jackling's reputation as a great engineer, thus built up, having first secured large holdings in the Utah Copper, joined the Colorado contingent in the flotation of Ray and Chino, Hayden, Stone & Co. becoming official underwriters for all bond and stock issues put out by those companies, the large clientele of that company at once assuring the absorption of any issue bearing their endorsement. And in this manner many millions of dollars have been secured from the general public by which means all the needed finances for any scheme, no matter how spectacular or chimerical, were readily obtained.

Notwithstanding the magnitude—on paper—of these three big enterprises, the ambition and greed of these promoters was not satisfied and so Butte & Superior was hooked up, and the public mulcted of several millions of dollars, no mean portion of which was contributed by local followers, many of whom had been beneficiaries of the profits arising from the gratuitous distribution of Ray and Chino shares, as before stated, and a considerable number of the sufferers from the Butte & Superior deal, it is said, were present at the "farewell banquet" given Manager Jackling early in the present month. The inside history of the Butte & Superior deal has already been given in a former issue of this journal.

Following this, these grasping promoters, with their precious mascotte—who in this case was supplemented by A. F. Holden—proceeded farther north and undertook, under the name of the Alaska Gold Mines Company, the rehabilitation and market promotion of the old and worthless property previously known as the Perserverance, and situated on the mainland of Alaska, about six miles from the famous Alaska-Treadwell gold mines, upon the successful operation of which it was hoped to float the shares of the Alaska Gold Mines Company, solely because of its proximity to this great mine. But the fact becoming exposed that the property of the Alaska Gold Mines contained no ores of any possible commercial value, of course an absolute collapse, so far as distribution of the shares is concerned, followed. True, the "noise" is still being faintly kept up, and considerable work is being done upon a great tunnel, but every prediction of the promoters has been discredited and this unsuccessful attempt to fleece the public forbodes an early and absolute failure of the scheme. The chief trouble in this case exists in the fact that the scheme was born about two years too late, and after the early demise of the master scheme had become a certainty.

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SMELTER SMOKE COMMENT

In spite of the fact that "big business" does not dare to say a word or to lift a finger against the smelters, no matter how much of a public nuisance they may have been proven to be, there nevertheless are scores of prominent people in the city and the county who have expressed their hearty approval, and have strongly commended Mines and Methods' smoke fight.

A prominent mining engineer and operator writes: "I have read with much interest the articles on smoke in Salt Lake City. I distinctly remember some years ago when the dust from the unmuzzled smelter stacks was reported by prominent professors and officials to be 'volcanic dust,' but I had some of it examined by an assayer, who told me the volcano that emitted that dust was within the valley. * * * Don't use my name in connection with this, publicly. I am in the employ of the Blank Blank Mining Co., and you can see they would not like me to butt in."

A leading citizen of Salt Lake says: "You have made the most significant revelation and the most important discovery ever made effecting the history of any city. Your smoke stories will mark an epoch in the growth of Salt Lake City. It may not come now, but it will come ultimately, and it will be principally because of your tracing the smoker to his home."

The owner of a large non-smoking furnace in this city says: "You have astonished this whole community; that the smelters are largely to blame for our city smoke is a terrible charge to make; terrible because we must have the smelters and their business, and yet it does seem that you are right in the matter. I am indeed sorry to be forced into this belief. However, the city was here first and I hope vigorous and effective action may be taken soon that will bring the least harm to the smelters and the greatest good to the city.

A Salt Lake City manufacturer comments as follows: "That is a pretty serious charge you have made against the smelters, but your bravery in speaking out in this matter is very refreshing. There has never been so plain a case of circumstantial evidence against any one anywhere as you have made against the smoke makers. I am a serious sufferer in both health and property loss from this exasperating smoke nuisance, and I will contribute one hundred dollars toward any campaign that will remove the smelters from the valley. However, I cannot wish them to suffer the loss of a single nickle, and as a property owner in this city I am willing that the city should bond itself as much as three million dollars to pay for the removal and rebuilding of the smelters a safe distance from here."

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SUMMER "SALT" STORMS

The so called "salt" storms that are common in Salt Lake City in the summer time when thunder showers occurring after a long dry spell wash down the dust from the atmosphere and spatter it over our windows and clothing in a very nasty manner, really contain no more salt than they do pepper; the salt flavor tasted is from the perspiration of the finger or hand of the taster.

The dust is almost exclusively desert dust so far as it is derived from points outside the Salt Lake valley, which the summer winds keep blown about from place to place, though it has just been ascertained from an examination of the gray dirt deposited last summer on the Boston building roof during a thunder shower from the southwest and carefully gathered at that time, that it contained smelter smoke particles in good quantities. As a matter of fact, a competent assayer made a careful fusion test of a quantity of this dust and found sulphur in appreciable quantities, a summary of the analysis revealing the amount to be at least one and one-half per cent of the total bulk of the dust gathered from the copper roofing after the shower.

Since the fires of Salt Lake City were not burning (in August), and since the storm came from the southwest across the Salt Lake valley, we are forced to the conclusion that the sulphur was not from the coal burned in Salt Lake City, nor from the spray (?) from Great Salt Lake, but that it came from the sulphur spouted into our summer sky by the smelters.

The amount, 1½ per cent, is however. but a very small amount of the sulphur combinations indicated to be in the air by this test, because during the storm. the surcharge of the sulphurs in the air. is transformed into sulphuric acid and other solution forms of sulphurs, by the rain drops, and this is not deposited as a dust or powder that can be gathered up as was the sample under consideration. From this observation it will be seen that the haziness of summer, which is washed down in great "gobs" by summer showers, is caused very largely in the Salt Lake valley by a prolific sulphur maker—or to be exact. THREE good, hardworking sulphur makers.

ktracting Gold From Gravel Deposits (VI.)

By AL. H. MARTIN.

elligent prospecting blazes the way ofitable mining. Unless the extent alue of a gravel deposit is known d all conjecture, the success of the prise is shrouded in doubt. As in mining, it has too often been the ce to outline operations and incostly equipment before a fitting ledege of the property has been red. In other cases inexperienced have supervised the perfunctory extion and testing of properties, and is that would have been valuable posts to the qualified engineer as blind walls to the untried men in e of the work. There are so many essentials entering into the extion of a placer property, that the r is worthy of a greater considerthan has been generally extended ot only is the prospecting of the d calculated to determine its merit ing operated, but also should indithe best methods to be utilized in tion of the gold.

the deposit is best worked by a e, or an elevator, or a steam shovel, ta so indicating should be gathered e testing of the material. Ground ifficult or shallow to warrant the lation of a bucket-elevator dredge be an ideal project for the dragxcavator or hydraulic monitor. And er deposit that was too deep for restricted methods, might develop a profit yielder if mined with es. The machine best adapted for articular work is the one that gives num results at a minimum cost, ut sacrifice of efficiency. Limited d, climatic conditions, local laws regulations affecting operations, ial status of the operating com—all these and many more factors nd consideration aside from the value and character of the deposit consideration.

CAUSES OF FAILURE.

vast majority of placer mining es are directly traceable to an imt understanding of the conditions lent at the outset. And it can be asserted that fully two-thirds of ilures were due to careless prospect-Even when the utmost care is exd in testing ground, the greatest tion must be exercised to guard st erroneous samplings. So well s danger comprehended by expert g engineers that in examination of California dredgable ground, and computation of average values throughout the deposit from the samples secured, it is customary to figure the gold content recoverable at 75 to 80 per cent less than the value indicated by samples from drill holes and prospect pits. There are so many chances for errors in collecting samples, and in their subsequent handling, that the reduction of indicated values about one-fourth is considered the one safe course. And actual operations have demonstrated the practice to be justified as there is always a certain amount of fine gold lost in handling the gravel, in addition to the varying values between indicated asd recoverable gold content.

While their cost oftentimes militates against their employment, prospect shafts are unquestionably the safest and most certain guides to the actual merit of a placer. This is particularly so when the work is in the hands of men who have not had long experience in sampling gravel. Presence of quicksand or very loose ground, requiring extensive timbering, often precludes the sinking of these shafts because of prohibitive cost, but under fairly favorable conditions their use is strongly recommended by most engineers. The shaft enables the examiner to gain a more comprehensive knowledge of the character of the ground and formation, facilitates the taking of a large sample, and largely reduces the possibility of errors in computing value of the estate if care is exercised in collecting the material.

It is the usual practice to sink round shafts with a uniform diameter of thirty-six to forty inches from top to bottom. If the deposit is deep, ranging below thirty feet the larger diameter is employed, but for comparatively shallow deposits the shaft with a three-foot diameter is usually found of ample size. With conditions favorable such shafts are sent down at a cost of 50 cents to $2 per foot, the expense varying with character of ground, labor costs size of hole, etc. While a fairly large shaft costs more than a smaller one, its use is recommended in testing fairly deep deposits, as it is false economy to cramp the workers, or handicap the engineer in his selection of samples. When the ground is wet and requires extensive timbering, the prospect shaft often ceases to be advisable, as the water not only runs up the cost and handicaps work, but so disseminates the gold values that it is generally necessary to check results with a nearby drill hole. Some operators use iron caissons when prospecting wet ground. In dry ground it is the usual practice to take only a small section of the shaft from top to bottom for testing, but in wet ground, or when the caissons are used the entire content of the pit is taken.

The location of shafts and distance from each other largely depends on the character of the ground. Hence a careful preliminary study of the deposit often results in marked saving of time and reduction of drilling costs. In making the early examination, the engineer usually sinks a few holes at widely divergent points to establish extent of commercial ground, and to learn if the gold occurs in channels or is fairly evenly distributed. If values are found fairly well disseminated and uniform, less testing is required, but if the gold occurs in bunches, or in narrow channels, careful work is necessary to conclusively demonstrate the actual merit of the deposit. After the first shafts have been completed, the engineer generally has sufficient data to outline the character of the subsequent work. The ground is then divided into sections and each division tested.

CORE DRILL PROSPECTING.

The correspondingly lower costs of prospecting with core drills under any and all conditions, and the rapidity with which work is preformed, has made this form of prospecting particularly popular with placer operators throughout the world. The drill works alike in wet or dry ground, and often under conditions where the shaft method would be beyond the range of economic consideration. Consequently the drill has largely displaced the prospect shaft in many districts, notwithstanding the admitted superiority of the latter means in many instances. A careless runner may render sampling of a deposit worthless and misleading by negligent driving of the casing. If the pipe is kept too far ahead of the drill bit the subsequent pumpings often fails to produce sufficient material to give a true index to the gold content of the deposit, while if the drill precedes the pipe an excessive quantity of material is drawn out by the pump. In either instance the samples are worthless inasmuch as they relate to actual value of the gravel. Such errors in drill running have been numerous when inexperienced or careless runners were in charge of machines, and it is largely because of such chances for error that many engineers prefer the prospect shaft. Another fruitful cause of inaccu-

rate samples is the tendency of some drillers to eliminate the casing when prospecting hard ground. The practice is considered as almost certain to give misleading results and is strongly condemned by most engineers, as there is always the danger of loose material below the driving shoe adding its gold content to the actual core drawn out by the pump. This naturally results in indication of a gold content far above that actually existing.

It is imperative that each foot of the casing pipe be marked, also the drill rope, in order that an accurate record of the changing depths of the hole, and efficiency of the drill be kept. The bit must be kept sharp and in best of condition. as a dull cutting edge may result in flouring of gold if used for any length of time. The type of drilling bit is determined by the character of ground, as a hard bedrock, or boulders require a heavier and wider angled cutting bit than loose gravel. A thin-bladed bit is desirable in drilling gravel as a heavy one would pack the material instead of cutting cleanly, and probably force some of it to the side of the pipe below the cutting shoe.

The type of drill used depends largely on its demonstrated efficiency, and the choice of the operator. In California placer prospecting the favorite machine is the Keystone No. 3, of the traction type. It is self-contained, and equipped with either an 8 or 10-horsepower boiler, or electric motor. Electricity is preferred for motive power whenever it can be cheaply obtained, but with the boiler attachment, wood, coal or oil can be used for generation of steam. The casing pipe is generally cut into 5 to 7-foot sections, with inside diameter of six inches. Practice has shown the best results are obtained with a long quick stroke and the drill is usually adjusted to deliver about 55 strokes per minute, with the stroke about 38 inches long. This prevents settlement and recutting of material between strokes, with a possible loss of fine gold. The casing must be constantly kept perpendicular, otherwise a bent pipe may force abandonment of the hole before the bedrock is attained.

The handling of the drill should never be intrusted to an inexperienced or careless runner when gold-bearing gravel is being prospected, otherwise inaccurate samplings and mechanical troubles are practically certain to develop. After the drill is raised from the hole, the loose material in the casing is drawn out by the sand pump; a vacuum machine composed of a hollow steel cylinder provided with a valve on a piston traveling the entire length of the cylinder. The vacuum produced by the action of the valve and piston sucks out the water, sludge and small rocks, which are held in the pump by the foot valve in the shoe. If the ground does not contain enough water, sufficient is kept in the casing to facilitate both drilling and pumpisg.

WHEN CARE IS IMPERATIVE.

As the gold content of most placer deposits is concentrated near the bedrock, particular care must be exercised in completing the final section of the drill-hole, otherwise the care taken in computing value of the upper ground will be of little value. It is on the pay-streak that the value of the enterprise depends, and on the accurate sampling of this depends in a large measure the success or failure of the project. Occasionally a rich pocket of gold may be tapped, and when this occurs, as indicated by the sharp rise in values, it should be noted apart from the record kept of the balance of the hole in order that real average values be not disturbed by a false calculation of excess gold. The pumpings are discharged into small rockers, and the panning carried on in iron wash tubs.

The amalgamation of the gold is carried on under the temperature that would prevail on the dredge, if identical conditions can be provided. If the gold does not amalgamate the reason should be learned, as many placer installations have been failures because of this feature. It then devolves upon the examining engineer to determine whether the deposit is of sufficient extent, and gold values high enough to justify provision of additional equipment for recovery of the refractory values. And even it should be remembered that the deposit must clearly display its ability to return the original investment to stockholders, plus a satisfactory interest rate.

Unlike a quartz deposit, the surface gravel project cannot be figured to produce beyond its demonstrated extent. There is no possibility of future work increasing productive area or value of the material, the enterprise must stand or fall on the results gathered in the prospecting. It is for this reason that the eventual yield of a surface placer can be figured closely, and its necessarily limited life correctly estimated. The ordinary dredge or hydraulic mining project is largely withdrawn from the usual conditions affecting the mining industry, save in exceptional cases, for its period of productiveness, and ultimate yield are capable of mathematical calculation. With the extent, character and value of the deposit conclusively established and comprehended, the intelligent engineer is in a position to recommend the best type of gold-extracting equipment for the particular requirement.

PURPOSE OF PREVIOUS ARTICLES.

In preceding articles the writer has endeavored to point out the merits and demerits of the various mechanical devices for recovery of gold from gravel channels, and the natural conditions that demand consideration before the particular installation is resolved on. Epitomizing, it can be said that the best machine for any particular purpose is the one that best accomplishes its purpose with a minimum expense and maximum efficiency. The experience of the supervising manager is an important element in the successful conduct of any enterprise, and particularly so when gravel mining is concerned. Careless prospecting of the deposit, or ill-advised selection of equipment not infrequently leads to failure, whereas careful work and and consideration in the beginning would have spelled final success. Any man can make a bonanza pay, but it takes a good man to coax profits from a poor mine. The desire to do does not always imply the ability to accomplish. Most men imagine they could manage a mine, but the tried engineer proceeds only when he is absolutely certain.

An immense amount of gravel mining is carried on without aid of mechanical appliances, but the methods are so simple and well-understood that they can be comprehended without special effort. Ground-sluicing is one of the oldest forms of placer mining extant. Man early learned to bring a stream of water from a friendly creek or rivulet to wash away a bank of gravel, and yield unto his keeping the coveted golden grains. This method is still largely employed whenever it can be utilized effectively, but requires considerable water and highly favorable topographical conditions to achieve best results. Oftentimes however it lends itself admirably to the plans of the small operator, particularly when a good tailings ground is convenient, and there are no unfriendly laws to prevent the worker from sluicing the debris to any point he desires. A good water supply, a few ditches or flumes, and sluices to capture the gold as the material is washed down, constitute the required equipment in most cases.

DRIFT MINING POPULAR.

Drift-mining is largely employed in working deep gravel deposits, and many of the best gravel producers in the world are mined by this method. Work is conducted much as in the mining of quartz. Shafts are sunk and drifts and crosscuts extended, or the work is conducted through adits and attendant workings. Generally it may be said that the ideal way of working a drift gravel mine is by means of adits and drifts and raises.

Surface prospecting determines the value and possible character of the deposit, so far as it has been opened, but extensive development work is essential to really indicate the merit of a drift mine. The work partakes of the characteristics of quartz mining, and it is impossible to guage the life of the enterprise or estimate its intrinsic value. The future is freighted with possibilities. This is particularly true of a new district, where the operator has little or nothing to guide him in his work. In older fields where neighboring companies have extensively operated, a fair idea of a new property's value may be gained by using advantageously the experience of the earlier workers.

Mining a gravel mine with shafts means the employment of hoisting, and frequently pumping, machinery. This naturally means that power costs, expense of purchasing and maintaining equipment, and higher labor costs must be figured on. When the deposit is worked through an adit, the hoisting and pumping expenses are eliminated. Transportation of the material through a long tunnel involves expense, but not to the extent that would attend identical work through shafts. Considerable timbering is generally required to sustain the walls and roofs of adits and drifts, also to prevent running of ground. It not infrequently happens that much of the gravel is of cemented character, necessitating the building of a gravel mill for crushing of the material and release of the gold. By the drift mining method, deposits are worked to considerable depth, and the practice is often the only one that can be advantageously employed. And there is a lure, a wonderfully enticing summon, in drift mining that no other form of gravel operation approaches. There is ever the chance of striking a rich pocket, ever the hope of transforming the mediocre prospect into a phenomenal producer. The channel may be barren of values today, but tomorrow, ah! tomorrow may see the gravel glittering with its golden freight; tomorrow may mean the laying of wealth in the lap of the prospector who has so long and fruitlessly dreamed of Fortune's smile. It is this song of the Sirens, this what may be, that makes the drift gravel mine so attractive to the prospector, the miner, the speculator. And it is this same spirit of adventure that has done so much to place mining in the forefront of the world's industries.

The gravel deposits were the first to yield gold to primitive man. The gravels of California started the greatest gold rush in the history of the universe and builded an empire in the great west. It was the rich surface gravels that focused the attention of the world on Australia, and then forced Alaska and the Yukon to the centre of the stage. And the development of another virgin gold field, if there still remains somewhere on earth another California or Klondike, will most certainly be heralded to the world by the auriferous treasures of the surface sands.

Liquidated Value of Mining Stocks

To the investing public generally there is no subject worthy more diligent study than that covering the valuation of mining stocks. Financially astute in matters pertaining to investments in railroad and other industrial securities, investors are prone to regard mining enterprises in the same light. In that respect they err. Primarily, the conditions surrounding a self-contained railroad or manufacturing enterprise are conducive to a progressive increase in assets from year to year in addition to a decided permanency of dividend-earning capacity. This is not true of mining enterprises, as reflected in the fact that each successive year's operations depletes the assets thereof. In short, the former is permanent, the latter transitory.

The liquidated value of any enterprise is one of the most important factors in determining the price [illegible] stocks. Strangely, however, the investing public seems to not consider this factor in relation to mining investments. This feature is reflected in comparative market quotations of railway, industrial, and mining stocks. Regardless of the ultimate value of the respective stocks it will be seen, from a perusal of market quotations, that the general list of mining stocks command prices greatly superior to many industrial enterprises, even under the circumstances wherein the assets, earning capacity, permanency of operation and dividend payments, together with other attendant factors, are largely in favor of the latter. This condition of affairs suggests the absolute necessity for more conservative reasoning in connection with mining investment securities.

The following article by Mr. Arthur O. Christensen and appearing in the January 1913 Mexican Mining Journal will doubtless be of interest to readers as it outlines many of the governing factors relative to mining stock valuation. We are presenting only the most salient features of the original article, together with an abbreviated list of large mining properties, the latter outlining the factors governing the liquidated value of the respective stocks, based upon the figures given by the management of the respective properties covering the physical and financial operating costs, etc. In reference to the foregoing we beg to call attention to the fact that the figures contained in the table mentioned, are subject to decided revision, particularly as regards percentage recovery of marketable minerals, costs of production per pound refined metal, grade of ore developed and treated, and ultimate ore tonnage recovery. The statement of condition of the Miami property is correct in but one item—cost of production—which should be 9.69 cents in place of 7 cents. Of the remaining companies operating costs, etc., all are incorrect, as the average production cost of copper ranges from 10 cents to 14.83 cents per pound. However, the object of this article is the presentation of fundamental principles underlying mining investments, and the table here used is merely illustrative of those conditions rather than as a presentation of the actual facts therein, which obviously could not obtain when it is considered that the figures given were prepared by the respective companies' management.

In view of the lack of anything like a clear or general understanding of the intrinsic values of those mining stocks which we see quoted in the daily papers the following discussion may be worth while, even though it attempts what perhaps appears the impossible; arriving at the intrinsic liquidating values of the shares of several representative mining stocks, with a discussion of the data and steps necessary in arriving at these values.

The calculations herewith made are based on seven fundamental items. The degree of accuracy with which this data can be estimated is dependent on the degree to which the mine in question is developed. Every mine has a demonstrated and a speculative value. The latter cannot be estimated with any degree of certainty so in a discussion of this sort only the more developed mines are considered, although even in most of these cases some allowance is made for probable, as well as developed ore. These seven basic items are as follows: (1) Annual production, (2) Recovery of metal per ton, (3) Cost of production, (4) Ultimate tonnage of ore in the mine, (5) Revenue not included in ore production, (6) Cash and other quick assets in ex-

cess of liabilities (not including convertible bonds which will probably be exchanged for stock), (7) Shares of stock issued (including those shares held for conversion purposes which are worth apparently the equivalent of the stocks or bonds for which they are likely to be exchanged.) * * *

The estimate of ultimate ore to be extracted from the mine is the most difficult one to make and has usually been the sine qua non of most attempts at mine appraisal. In the case of the "porphyry coppers" the minimum of this item is definitely known. * * *

Where ore reserves are large in proportion to rate of production or there seems a considerable speculative value in the property the stock may rightly earn a lower percentage.

If a mine is capable of maintaining its present rate of earnings for 21 years, at the end of which time it be entirely exhausted, its earning should be 10% of its present price (its price should be $\frac{100}{10}$ of its earnings) in order to refund the principal at the end of this time and pay 7% interest on the investment, as will be discussed below. Such an age for this class of mines seems a fair estimate. Of course a mine usually does not maintain its maximum output and average grade of ore to the end. We do not expect that the mines taken up in the accompanying table will cease operating at the expiration of the periods estimated for their respective lives, but it is probable that the value of these mines would be about the same whether they maintain their earning capacity for the period given and then cease entirely, or die a gradual death, as is more likely to be the case. For the purpose of this paper it is simply following accepted practice (which we feel is justifiable) to estimate the life of the better developed copper mines as about twenty-one years, adding to or subtracting from this estimate as the comparative conditions of the properties seems to require.

Each person must judge for himself whether the estimated life of the mine, and in fact the other six fundamental items, are too favorable or too severe for the particular mine in question; whether the mine has its estimated ore tonnage largely developed or simply has a promising prospect of ultimately obtaining that much. In other words he must judge whether the risk of the mine not coming up to the given estimates is greater or less than the chance of its doing better.

On first consideration this method of estimating the life of a mine may seem so crude as to defeat the whole purpose of the article. Suppose the mine to have an effective life of 32 years instead of 21 (approximately 50% larger), what will be the difference in the present value of the stock? Turning to Fig. 2 we see that (allowing a 7% return on the investment) the one running 21 years must yield 10.1% in order to return principal at the end of this time. Each dollar annual revenue therefore has a liquidating value of $\frac{100}{10.0}$ =$9.90. Where the investment runs for 32 years the Fig. shows the required rate of earnings to be 8.6% of the value of the investment, which is then $\frac{100}{8.6}$ =$11.62 or 17.4% greater than in the former case. Thus the mine with more than 50% longer life is worth only 17.4% (or about a sixth) more.

To take an actual case: Ray Con. is estimated to have a life of 23 years. Its earnings should therefore be 9.7% in order to yield 7% on the investment and amortize the principal at the end of 23 years. Utah Copper has an estimated life of 40 years (77 per cent longer) Fig. 2 shows that 8% is required in this case. For each dollar of annual earnings Ray Con. is worth $\frac{100}{9.7}$ =$10.30 and Utah Copper $\frac{100}{8}$ =$12.50, or 21.3% more although its life be 74% more. There is thus an economic limit to developing ore reserves, even for a porphyry mine. Fig. 1 shows that, assuming money worth 7% if Utah Copper were to add another year's supply to its reserves the present value of the profits to be derived therefrom is less than 7% what the profits will be 41 years hence. Whether we estimate the life of a mine at 20 or 25 years makes a difference of only about 10% in the capitalized value of its earnings.

The remaining three items on which calculations are based are obtainable from reports issued by the companies.

The accompanying table gives an illustrative list and works out the intrinsic value of the stock in each case. The figures given are those expected to hold for the whole estimated life of the mine, should present plans and conditions be continued. Increased ore reserves or additional treatment facilities would change the fundamental data so as to necessitate corresponding alterations in the calculations. This will probably soon be the case with such mines as Braden, but at present is only a speculative value. As conditions at the mines are altered the problem becomes altered and the value of the stock should correspondingly fluctuate.

Having assumed the life of the mine, its earnings may be capitalized in several ways. The simplest is to consider all earnings payable in a lump at the expiration of half the mine's life, this being the average time to which payments are deferred. Assuming payments to be made in equal installments over a period of 18 years, for example, the whole may be considered paid at the expiration of 9 years. Fig. 1 shows that, with money worth 7% the present value of such a sum is worth 54½% of its total or 18.545 =9.8 times the annual payment.

H. C. Hoover introduced the practice of capitalizing a mine's earnings by first deducting from each year's earning an amount such that if reinvested at 5% will, at the end of the estimated life of the mine, be equal to the original investment. The remaining income is considered a legitimate interest (7% for example) on the value of the property.

$$I = \frac{((1+i)^{n-\frac{1}{2}}-1)\ (E-r)}{\log_e (1+i)}$$

where I= per cent increase desired, i= the amount annually paid as interest per dollar. E-r=per cent reinvested for amortization. n=number of years required for desired increase of capital. Modifying this for our special case where I=100, and i=.04, the equation reduces to:

$$n = \tfrac{1}{2} + \frac{\log\left(\frac{3.921}{E-R} + .981\right)}{.01703}$$

where n=number of years the mine is to last, E= per cent earnings r=per cent annually paid on investment (herein taken as 7%).

Fig. 2 gives a series of curves showing this under varying conditions. From this

MINES	Shares issued (including those to be issued for bond conversion)	Annual Production. (Thousand tons)	Per cent Copper Content (in ore as mined)	Per cent Recovery	Recovery in pounds per ton	Annual Production (Million Pounds)	Cost per Ton	Cost per Pound Copper (cts)	Value of Other Metal (in cts.) per lb.	Annual Profit from Metal Production (14½c) per lb.	Ultimate recovery Ore (million tons)	Estimated Life of Mine (years)	Other Revenue (Annual)	Cash and Other Assets Independent of Mine	Same per Share	Profit per Year per Share	Rate of Earnings Necessary to Liquidate and Pay 7%	Allowance of Deferred Operation	Earnings Capitalized	Total Liquidated Value
Braden	2,600,000	1.000	2.60	66	34.3	34 3	2.32	6¾	(1)	2,660,000	22	22	....	900,000	.35	1.02	9.9	.97	10.00	10.35
Chino	870,000	1.700	2.10	70	29.4	50	2.20	7½	(1)	3 750,000	51	30	....	200,000	.23	4.30	8 8	.98	37.90	38.15
Miami	748,325	1.050	2.25	72	32.4	34	2.27	7	.17	2,600,000	21	20	....	100,000	.80	3.48	10 4	.99	33.00	33.80
Nev. Consolidated	1,998,762	2,870	1.64	69	22.6	65	2.08	9,2	.7	3,900,000	43	15	1,300.000	3.000.000	1 50	2.60	12	....	21.65	23.75
Ray Consolidated	1,587,500	3.330	2.00	68	27.2	90	2.25	8¼	.006	5 616,000	77	23	....	1,000.000	.63	3.54	9 7	.97	35.40	36 00
Utah Copper	1,612,649	6,760	1.50	69	20.7	140	1 86	9	1.0	9,100.000	270	40	200,000	24.000.000	14 90	5 77	8	.99	71.30	85.20

it is seen that to pay 7% on the investment and return the principal in 18 years a yield of 10.9% is required. The value of the investment is therefore $\frac{100}{10.9} = 9.17$ times its annual earnings, which compares with 9.8 as found above by using Fig. 1: this discrepancy representing the difference whether the amortization fund is invested at 7 or at 4%.

The average price of copper is taken as 12½ cents a pound. This has been approximately the price in the past, and there seems no more reason for a lower than a higher price during the next twenty years.

Where the caving system is used, as is the case with Ray Con., Miami and others, it must be remembered that some 15% of the ore will be lost, and the grade of that which is mined will be lowered by admixture of waste. Even where ore is stripped and "steam shoveled" some waste is necessarily mined and a portion of the ore is lost. Thus both the tonnage and grade of the porphyry ore bodies should be modified to represent the ore which will be mined.

The value of stock of subsidiary companies which are independent of the controlling company is given in the column "Cash and Other Assets Independent of Mine."

While the data given in the accompanying table are only approximations, we believe they are as nearly correct as can be estimated from information obtainable. It is probable that time will show these estimates to be nearer the true values of the stocks than is represented by market quotations. If traders in the Stock market were in the habit of giving as much consideration to what they buy as is given to each stock considered above there would be fewer losses sustained, and the market would not have such an undesirable reputation

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A new alloy, containing a large proportion of iron, has been patented by John F. Duke, of Manchester, England, in United States patent 1,044,761 of 1912. The proportions are: iron, 50.30 per cent; nickel, 19.16; copper, 29.14, and aluminum, 1.40 per cent. It is white, non-corrosive, and resists the action of vegetable acids and the atmosphere well If more hardness is desired add from 1 to 2 per cent of tin.

Nitrogen amounting to 810,000,000 tons has been wasted in the United States since 1893 through the use of the old-fashioned beehive coking oven By-product coke ovens would have yielded from this coal 9,315,000 tons of ammonium sulphate, worth $60 per ton, which could have been used as a fertilizer.

Ultimate Source of the Metals

By BLAMEY STEVENS.*

It is now generally agreed that most metals have been brought to the surface of the earth by volcanic agencies. The question as to how these metals came from the volcanic matrix to the mineral deposit has been often discussed.

It might be useful to give more serious consideration to the ultimate origin of the volcanic material. It is possible that some light might thus be shed on the persistent associations of some metals with certain particular kinds of rocks. For example, the very general association of gold with acid types of igneous rocks, of tin with granites or quartz-felsites, of certain types of deep-seated copper-deposits with magnesian eruptives, and so on.

One interesting question is as to whether the metals brought near the surface by volcanic agencies appear here for the first time, or whether they came from the central core of the earth. The interior of the earth is, without doubt, much more highly metallic than the crust, and so the core is often thought to be the origin of many of the metals which are uncovered by man.

THE DIFFERENTIATION THEORY.

Although a great many theories bearing upon these matters have been discussed,[1] the only one now considered as worthy of much consideration among American geologists is the "Theory of Differentiation of Igneous Magmas."[2] According to this theory, lakes of molten magma are supposed to exist very far down beneath the earth's surface. In these lakes a process of differentiation is supposed to be going on whereby the liquid magma is split up into two or more liquid phases Each of these phases is supposed to take with it the metallic constituents for which it has the greatest affinity.

This theory is an endeavor, in the most simple way, to account for the emission of a varying and widely-different series of igneous rocks from nearly, if not quite the same vent. The older idea of separate reservoirs was no longer feasible when there appeared to be so many necessary—for instance—seven at Tonopah and nearly twice as many at Goldfield. And thus the idea of the gradual splitting up of one magma was reached.

Like the old simple theory of the sun and stars moving around the earth, the differentiation theory cannot be definitely disproved, but it involves such a reversal of physical conditions, as we know them, from our experience on the earth's surface, that the probability of truth of the theory is reduced to a very small fraction.

The physical conditions which, according to the differentiation theory, are necessary, are that a liquid silicate magma shall split up into two or more liquid silicate magmas. On the surface of the earth we know of no case where this is so. If pressure and temperature could be considered to alter these conditions for silicates in general, it is very unlikely that some extreme type of silicate would not exhibit the same phenomenon on the surface of the earth.

Moreover, the same generalization applies to other than liquid silicates; for example, liquid sulphides, liquid arsenides, and also, where we have had a lot of experience, with solutions in water.

It is true that variations of physical conditions, such as heat, gravity, or electric state, in different parts of a solution may produce corresponding variations in its composition These effects must, however, be so small as to be negligible in magma reservoirs. If such reservoirs were of large dimensions, convection-currents, due to loss or gain of heat, would entirely nullify any such differentiation effect.

Fractional crystallization is not seriously advanced as a general explanation of the emission of lavas of varying composition from the same vent, and

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* Mining Engineer, Temascaltepec, Mexico, Trans. Am. In. of Mining Engineers, March, 1913.

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[1] Dutton, Hawaiian Volcanoes, Fourth Annual Report, U. S. Geological Survey, pp. 75 to 219 (1882-83).

[2] Iddings, Igneous Rocks, chap. vii. (1909).

[3] Zeitschrift fur praktische Geologie, vol. i., pp. 4 to 11, 125 to 143, 257 to 284 (Jan., Apr., July, 1893).

[4] Philosophical Transactions of the Royal Society of London, vol. clxiii., pp. 147-227 (1873).

[5] Trans. xl., 475 (1910).

[6] The Crystalline Structure of Metals, Philosophical Transactions of the Royal Society of London, A, vol. cxcv., pp. 279 to 301 (1900).

[7] Thomson and Tait, Treatise on Natural Philosophy, p. 423 (1893).

[8] Rankine's Applied Mechanics, 4th edition, p. 303 (1868).

[9] Trans., xl., 475 (1909).

[10] Applied Mechanics, 4th edition, p. 212 (1868); also Philosophical Transactions of the Royal Society of London, vol. cxlvii., pp. 9 to 28 (1857).

[11] Trans., xli., 650 (1910).

[12] Iddings, Igneous Rocks, p. 257 (1909).

[13] Barus, American Journal of Science, 4th Series, vol. ix., No. 51, p. 173 (Mar., 1900).

[14] Bulletin No. 109, U. S. Geological Survey, pp. 27 to 32 (1893). See also A Treatise on Metamorphism, Monograph XLVII., U. S. Geological Survey (1904).

[15] Trans., xli., 650 (1910).

[16] Geikie, Text-Book of Geology, 3d edition, p. 231 (1893).

[17] Idem, p. 244.

[18] Idem, p. 255.

there is no reason for discussing this process at length. To illustrate what is meant by fractional crystallization, we might imagine a garnet to be melted up and then slowly cooled. It would not again crystallize out as a garnet, but as two or more silicates, or as silicates and a residual magma, or glass. As the silicates are formed, the residual magma changes in composition, and with a fractional crystallization theory would be considered to be extruded at periods during such a history. Fractional crystallizations of aqueous liquids carrying silica and other materials have been formed in the end-stages of solidification on comparatively large scales, but these aqueous crystallization phenomena cannot be advanced as any general explanation of the varying composition of successive volcanic outpourings. A proof of the general mixing effect which obtains in magmas, except during the last phases of total solidification, lies in the fact that the large silicate crystals (phenocrysts) which are formed, remain more or less evenly distributed throughout the magma.

Fractional crystallization as a means of segregation has been given as an explanation of certain peripheral deposits of pyrrhotite and nickel-ore. Even this peripheral pyrrhotite-nickel type of deposit, which is described in great detail by Vogt,[3] may now be equally well explained on the more modern and more rational emanation theory; that is to say, they are more likely to be interstitial and replacement depositions made in the solidified periphery by emanations from the still-solidifying central portion of the intrusion.

Some titaniferous iron-ores have been cited as cases of either differentiation or fractional crystallization, and it is quite possible that this may be the case, but titaniferous iron-ore is not a silicate, and proof of its differentiation from silicates would be no proof of the possible differentiation of silicates.

MISCIBILITY OF LIQUIDS.

The tendency of liquids to mix is not due to affinity but rather to cohesion. Liquids possess the quality of cohesion in common with solids, and the property of continuous rearrangement of molecules in common with gases. Any liquid exhibits the property of cohesion among its own constituent molecules. When two liquids are placed together the cohesion may be greater among unlike molecules than among like molecules. In this case the liquids are miscible.

It is well known that in the smelting-furnace a liquid metallic lead-bullion differentiates itself from the liquid silicate slag; in other words, the liquids are immiscible.

No one has ever known, however, of a liquid silicate splitting into two liquid silicate constituents; in other words, liquid silicates are miscible in all proportions.

High temperatures tend towards miscibility; that is to say, away from differentiation. If liquids were apt to contract on differentiation, physical conditions might be so changed at great depth as to render the differentiation of silicates possible. As a matter of fact, when two liquids are mixed there is no known increase of volume large enough to be considered as even a small factor tending towards differentiation.

In 1875 R. Mallet[4] tried to show that igneous fusion is due to horizontal compressive crushing in the earth's crust. He calculated the energy necessary to crush rock into an impalpable powder, and showed that enough heat could thus be generated in the world to account for the fusion of all the lavas and igneous intrusions which are being made.

It was subsequently pointed out, however, that the heat so formed could not be concentrated locally so as to produce a sufficient elevation of temperature for the fusion of rocks.

I have shown[5] that the extension of moderately inclined fissures to considerable depths implies that much superior stresses are required to break rocks at great depths than near the surface. Consequently, a great deal more heat may be developed in the crushing of a deep-seated rock-mass than was formerly contemplated. Moreover, this crushing effect can be repeated over and over again on the same material, producing each time an additional amount of heat. The squeezing of a mass of sand might illustrate this to the average mind. Work is certainly done on the sand and turned into heat, but no particle of sand is necessarily broken or worn. By this crushing effect, under great pressure, the cohesion of a rock-mass is not necessarily reduced. The rocks at great depth are not, in fact, crushed into powder, but forced to flow like plastic material. Pebbles in crushed conglomerates are often considerably flattened, and have even been known to be reduced to the thickness of a leaf.

This form of flowage may be brought about by the yielding of the material beyond the elastic limit, or by the agency of aqueous or other solutions in the pores of the rocks. Such solutions tend to dissolve material from the crystal-faces which happen to be nearly at right angles to the direction of greatest stress, and to deposit it on the faces which are more nearly at right angles to the direction or directions of least stress. In order to estimate the energy transformed to heat, it does not, however, matter how the distortion comes about if we can ascertain the amount of stress and distortion involved.

In order to define our ideas let us represent the mean vertical pressure by DH, where H is the depth at which the distortion is taking place and D the mean density of the overlying rock. Let the greatest horizontal pressure be DHI, where I will be the ratio between the greatest and the least stresses. The stress difference which caused the distortion is then DH–I-1.

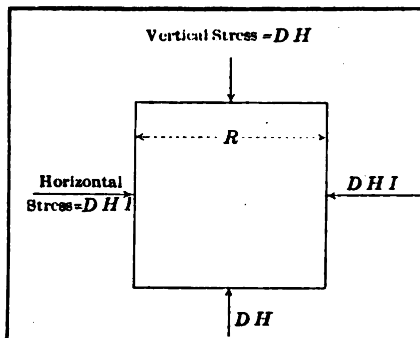

FIG. 1.—DIAGRAM OF STRESSES.

Suppose this pressure difference to compress a unit cube of the rock, Fig. 1, so as to make its least breadth R, instead of unity. As the block must expand inversely as its thickness, the area on which the stress difference now acts is $\frac{1}{R}$.

The increment of energy turned into heat for a decrease —dR of the least dimension will then be $\frac{-DH(I-1)dR}{R}$ so that the total energy of distorting the original unit cube of rock is $-DH(I-1)\log_e R$

If J be the mechanical equivalent of heat, the amount of heat formed per unit weight of rock will be $\frac{-DH(I-1)\log_e R}{J}$. From this formula I have prepared Table I, which is intended to appeal to the judgment of geologists on the general probability of truth of the theory.

Much of the distortion of rocks may be due to metasomasis or the re-formation of crystals, but microscopic examination of nearly all distorted rocks shows that the crystals are permanently strained and therefore the yielding-stress is a criterion.

The phenomena of yield in metals has been studied by Prof. J. A. Ewing and W. Rosenhain,[6] who find that it consists of a number of minute shears which occur mostly along the cleavage or gliding-planes of the crystals.

So far as I know, the effect of other than simple stresses on yielding has never been experimentally studied. This is owing, no doubt, to the difficulty involved in simultaneously measuring stresses in more than one direction on an experimental specimen.

Darwin[7] assumed that the stress difference necessary to yielding was constant, but, as first pointed out by Hodgkinson,[8] this is contrary to the deduction

from crushing tests, where the rupture is usually a shear.

FRICTIONAL STABILITY.

In a former paper,[*] I showed that as soon as these yielding cracks or shearing-planes are formed, the rock-mass becomes subject to the laws of frictional stability of a granular mass, as deduced by Rankine; and in general the ratio of greatest to least stress becomes $I = \frac{1 + \sin(\text{ang. } X)}{1 - \sin(\text{ang. } X)}$ where X is the angle of repose of the granular material.

It will be noticed that I is determined only by the fractional angle or by the coefficient of friction. Friction is one of the most constant physical quantities we know of. The smallest quantity of solid matter we can weigh has about the same angle or coefficient of friction as the largest quantity we can weigh. We are therefore justified in assuming that some degree of constancy will be maintained up to pressures which destroy the solid properties of the material.

Determined experimentally,[10] X is the angle with the horizontal to which a plane may be tilted before any given object will slide down on it.

For conditions at comparatively small depth between freshly broken rock surfaces X is about 42°, and therefore for simple rock-pressures I = 5, approximately, or if the gravitational water-pressure is added and the greatest stress is assumed to be horizontal, I = 3.5. According to the evidence afforded by intrusion[11] of magmas, I is always reduced where there is evidence of plastic flow. It is impossible to say what the exact value may be, but it seems reasonable to put it at about 2.0.

TABLE I.—British Thermal Units Evolved by Various Stress Differences and Deformations $= \frac{H\ (I-1)\ \text{Log } e\ R.}{J}$

Stress Difference in Feet of Rock Head — H (I-1.)	Deformation Ratios = R.						
	$\frac{1}{2}$	$\frac{1}{5}$	$\frac{1}{10}$	$\frac{1}{20}$	$\frac{1}{50}$	$\frac{1}{100}$	$\frac{1}{1000}$
1,000	1	2	3	4	5	6	9
2,000	2	4	6	8	10	12	18
5,000	4	10	15	19	25	30	44
10,000	9	21	30	39	50	59	89
20,000	18	41	59	77	101	118	178
50,000	45	103	148	193	251	296	444
100,000	89	206	296	385	503	592	888
200,000	178	411	592	770	1,006	1,184	1,776
500,000	445	1,028	1,480	1,925	2,514	2,959	4,439

TABLE II.—Values of Stress Differences (I—1) H for Various Values of H and I.

Vertical Depth or Head, H Feet.	Stress Ratio, I (for Simple Rock-Pressures).						
	1.1.	1.2.	1.5.	2.0.	2.5.	3.0	5.0.
1,000	100	200	500	1,000	1,500	2,000	4,000
2,000	200	400	1,000	2,000	3,000	4,000	8,000
5,000	500	1,000	2,500	5,000	7,500	10,000	20,000
10,000	1,000	2,000	5,000	10,000	15,000	20,000	40,000
20,000	2,000	4,000	10,000	20,000	30,000	40,000	80,000
50,000	5,000	10,000	25,000	50,000	75,000	100,000	200,000
100,000	10,000	20,000	50,000	100,000	150,000	200,000	400,000
200,000	20,000	40,000	100,000	200,000	300,000	400,000	800,000
500,000	50,000	100,000	250,000	500,000	750,000	1,000,000	2,000,000

TABLE III.—Rise in Temperature, in Degrees Fahrenheit, Induced in Rock by Various Stress Differences and Deformations (Specific Heat Assumed = 0.2).

Stress Differences in Feet of Rock Head	Deformation-Ratios = R.						
	$\frac{1}{2}$	$\frac{1}{5}$	$\frac{1}{10}$	$\frac{1}{20}$	$\frac{1}{50}$	$\frac{1}{100}$	$\frac{1}{1000}$
1,000	4	10	15	19	25	30	44
2,000	9	21	30	39	50	59	89
5,000	22	51	74	96	126	148	222
10,000	45	103	148	193	251	296	444
20,000	89	206	296	385	503	592	888
50,000	223	514	740	963	1,257	1,480	2,220
100,000	445	1,028	1,480	1,925	2,514	2,959	4,439
200,000	890	2,056	2,960	3,850	5,028	5,918	8,878
500,000	2,225	5,140	7,400	9,625	12,570	14,795	22,195

Table II. gives the values of the stress difference as rock head for several values of H and I. This value of the stress difference is to be used to find the heat formed, from Table I., or the corresponding temperature increment, from Table III.

Neither Table I. nor Table II. is based on any assumptions; they are practically absolute. I have purposely constructed these tables in such a way that any person interested may place what value he pleases on H, I, and R and judge if the amount of heat formed, according to the tables, is sufficient to produce fusion.

The terms heat and temperature must not be confused. For example, to fuse 1 lb. of ice from and at 32° F. requires 143.5 B.t.u. of heat, but it does not require any change of temperature. The figure 143.5 is called the latent heat of fusion of ice in Fahrenheit units. An additional amount of heat is required if the material has to be raised to fusion-temperature before being fused. For ice it takes 0.504 B.t.u. for every degree Fahrenheit which 1 lb. of the material is raised before being fused. The figure 0.504 is called the specific heat of ice in Fahrenheit units.

As it is known that the earth is solid practically to the center, it follows that the fusion-point of rocks must rise with the depth so as not to be overtaken by the increment of temperature with depth which obtains in portions of the earth where metamorphism and vulcanism are not proceeding. If this were not the case, all rock magma below 150,000 ft. would be in a state of fusion.

If the deformation be measured on solid rock which has not been melted, the heat-values given in Table I. are the heats necessary to raise the temperature from that which is normal, at the depth where fusion takes place, to the temperature of fusion. After the fusion-point is reached and a small quantity of rock is reduced to the liquid state, the deformation takes place preferably in the semi-molten or pasty material, which is thereby superheated beyond the fusion-point. The melted rock immediately gives up its excess of heat to the surrounding rocks, and supplies the heat for fusing more rocks. Thus, if the stress-ratio (R), determined by measurement of schistose deformations around a batholith, is $R = \frac{1}{10}$, and if the rock head (H) is estimated at 100,000 ft., and the stress-ratio (I) at 2, the stress difference is seen from Table II. to be 100,000 ft. rock head, and the heat necessary to raise the temperature from normal (for the depth considered) to fusion-point (for the depth considered) is 296 B.t.u. This at a specific heat of 0.2 gives $\frac{296}{0.2} =$ 1,480° F. difference of temperature. If the fusion-temperature can be reached by the heat generated, it is clear from what has been said above that the latent heat of fusion will be forthcoming. I have therefore added Table III. showing the temperature increments corresponding to the various deformation-ratios and stress differences which bring the rock to fusion-temperature.

The heat necessary for the fusion of rocks must vary with the depth, and also with the kind of rock. The temperature of fusion is necessarily higher

in depth, but the latent heat of fusion will be less, and the natural temperature of the undisturbed rock greater.

At the surface, the normal fusion-point of igneous rocks is from 1,000° C. to 1,200° C., or from 1,800° F., to 2,200° F., and the specific heat from 0.2 to 0.3.

Others may place what limitations they think necessary on the various factors, but they will doubtless find that there is usually sufficient heat generated to account for igneous fusion.

EVIDENCE IN VOLCANIC HISTORY.

It has been found that, historically, a volcano generally begins with the ejection of a lava which is neither very base nor very acid in composition. It tends, in the course of time, either towards a very acid extreme or towards a very base extreme of lava composition.[12]

On the surface of the earth the basalts are the most fusible rocks, those which are either more basic or more acid being less fusible. With depth, however, there are two very important modifying conditions.

First, the solution of silica in aqeous material tends to lower the melting-point of the more acid rocks. The contraction [13] which takes place when this occurs accentuates this lowering of the fusion-point when high-pressure conditions are superimposed. Second, the greater expansion of the basalts at the instant of fusion makes them less easily fusible when under high pressure than rocks of mean acidity.

It is therefore probable that the first rocks which become sufficiently liquid to flow are those of mean composition, such as the andesites, and that only as these become exhausted is the metamorphism carried further and the less fusible rocks or rock-mixtures melted.

Many refractory rocks such as quartzites, clay slates, limestones, etc., obviously remain unfused, but it may often happen that fusion starts at the contract between two or more refractory rocks, and they may then continue to be melted down into a fusible mixture.

In a metamorphic region the most fusible mixtures afforded by the contacts are evidently formed first. After a while either the base or acid material becomes more or less used up and magma tending towards one of the extremes and at a higher fusion point and under greater stress has to be formed.

Finally the stress necessary for fusion at this center becomes so high that the adjacent regions of unmelted rock reach the fusion temperature and relieve the stress. The refractory residue of the old center of fusion then ceases to be fused any further.

Mountain chains have a great degree of permanence. This can be explained on the sassumption that underneath them are zones of weakness in the earth's crust which make it yield by plastic flow and fusion.

An obvious cause which can be assigned for such weakness is the heat generated by plastic flow. Such heat would render further plastic flow and fusion more facile, so that the mountain chain would support itself in one position in spite of rapid denudation or creep gradually in one or both of the directions at right angles to its axis.

In great bathyliths there is generally evidence that the rocks surrounding the igneous cores have been nearly in a state of fusion. These rocks are usually of gneissic or schistose character, showing much plastic flow and changing gradually into the igneous material.

It is rare on obviously intrusive igneous contacts not to find a very sharp line as between intrusive and wall-rock.

W. S. Bayley has described a small occurrence at Pigeon Point, Minn., U. S. A.,[14] where there is igneous fusion at the contact between acid and base igneous rocks (keratophyre and gabbro). The locally-fused rock has a composition between that of two parent rocks and grades into each of them. It was unusual that metamorphic forces should have been brought to such a pitch as to cause the necessary rise of temperature for fusion in this case and then have been released before they had melted the country for miles around.

As I have shown elsewhere,[15] the lava intruded in the regions where the horizontal stress exceeds the vertical, takes a horizontal tabular form and raises the superincumbent strata. These upper strata ultimately become convex enough [16] to overcome their excess of horizontal stress and the lava then breaks vertical rents upward for itself. As it gets nearer to the surface the aqeous vapors and other gases which it contains expand very greatly, and the column of lava is thereby so much lightened that the whole, or part, of the liquid contents of the horizontal cavity are rapidly extruded. The surface then subsides [17] again and the vertical openings are sealed. When a sufficient amount of lava has again accumulated in the laccolith form it is again extruded, and so on again and again.

In the absence of aqueous vapors and other gases, the pressure may be just enough to extrude the material slowly and regularly as "Fissure (Massive) Eruptions." [18]

The calculated position of the seat of a volcanic earthquake is not necessarily coincident with the place of formation of the magma. The earthquake is more probably due to the above mentioned extrusive effects occurring at less depth.

COMPOSITIONS OF ERUPTIVES.

The idea that igneous rocks are identical with ancient surface and intrusive formations is an old one, but geologists were not generally prompted thereby to conceive that bathyliths were not intrusions, but igneous sources.

The mean composition of the material issuing from a volcano is strikingly like that of the fusible sedimentary rocks. The lava corresponds to ordinary surface-rocks in fusible proportions. The steam corresponds to the water of their pores, the hydrocarbons to some of their coal and mineral oil; the chlorine closely suggests the sea-water which they often contain, and nitrogen suggests nitrates and dissolved nitrogen.

It therefore appears, according to this hypothesis, that gold and its siliceous rock associates may have been brought together at the surface as sand and gravel-deposits, from which all the more easily decomposed minerals, which also happen to be the more base minerals, have been washed.

The same reasoning may apply to tin, though in a lesser degree, a more delicate adjustment of conditions being necessary for the depcsition of this metal.

Silver, though in many ways an associate of gold, also occurs as a constituent of base minerals which are easily slimed, and which, in the course of denudation, find their way to the sea, where they may settle with the fine sediments. These have usually a composition approaching that of the more base igneous rocks.

It is not as easy to explain the circulations of copper. Being an exceedingly soluble metal, however, it may find its way to the sea as a solution, being precipitated in very small quantities over vast areas.

Lime is precipitated in a similar manner, and its calcium is often partly replaced by magnesium.

This selective resemblance of copper and magnesium may explain the frequent association of the two elements in igneous rocks.

Sulphur, from the sulphides, having become a sulphate or sulphurous salt, is also very soluble, but is ultimately redeposited, often as gypsum. From this state it is probably reduced by carbonaceous matter.

This carbon becomes buried in considerable quantities with the sediments, and probably induces the highly reducing nature of all eruptives and their emanations and the CO_2 which occurs in the latter.

It is well agreed that sediments have been brought down to depths where severe metamorphism goes on. It is only a minute step more to fusion.

The oldest rocks we know of as sediments do not go far beyond the history of life on the earth's surface. Before this time there must have been a vast period when water was too hot for life, atmosphere pressure was greater, and the physical commotion of land, water, and atmosphere enormous. It therefore follows that a vast amount of churning up of rocks, and incidental concentration of their minerals, must have occurred before the dawn of known stratigraphical history. These rocks are now doubtless fused or metamorphosed beyond recognition. Indeed, without life we know or no way by which they could be identified.

The Decadence of Utah Copper

We are reproducing the following article from L'Argent of Paris, and dated Wednesday, April 4th, just as it appeared in that journal. It is composed largely of the comment of Mines and Methods on the fourth quarterly report for 1912 of the Utah Copper Company, but it reflects perfectly the French opinion of that concern's peculiar methods of publicity. Referring to our comment on the report L'Argent says: "That excellent review, Mines and Methods, gives us another sound of the death-knell of Utah Copper, and we are glad to be the first to give our readers the comment of a confrere always well informed and of a competence which we do not have to praise."

La décadence de la Utah Copper

Pour masquer la situation réelle, la Compagnie a recours à des procédés spéciaux de comptabilité ; d'autre part, l'exploitation est gravement entravée pendant la période d'hiver, fait important que l'on a toujours caché aux capitalistes français.

A la faveur d'une réclame tapageuse, les intéressés étaient peu à peu parvenus à persuader à nos capitalistes et même aux milieux financiers français que la *Utah Copper* était une véritable merveille moderne. La vérité était d'autant plus difficile à discerner que l'on ne connaissait de l'affaire que ce que les promoteurs voulaient bien nous en dire. L'excellente revue *Mines and Methods* nous donne un autre son de cloche et nous sommes heureux de réserver à nos lecteurs la primeur des commentaires d'un confrère toujours bien renseigné et d'une compétence dont nous n'avons pas à faire l'éloge.

Le rapport de la *Utah Copper*, pour le quatrième trimestre de 1912 a été publié vers la fin février. C'est un document au moins bizarre, qui laisse les actionnaires rêveurs, en même temps qu'il donne passablement de fil à retordre aux porteurs de titres désireux de se faire une idée exacte de ce que l'entreprise réserve pour l'avenir. Lorsque ces derniers liront les histoires à dormir debout qui précèdent l'aveu que fait la direction d'un déficit qui ne s'élève pas à moins de $ 82,247 (423,575 fr.) pour le trimestre, et quand ils se seront aperçus des précautions dont l'exposé du bilan a été entouré, il est probable qu'ils s'étonneront de ne pas trouver un déficit encore plus considérable, eu égard à la façon dont est établi le compte profits et pertes.

Le bilan montre en effet qu'il a été extrait 930,595 tonnes de minerai d'une teneur de 1.104 0/0, soit 22 livres de cuivre par tonne. Le poids en cuivre brut a été de 12,906,582 livres et le coût de production ressort à 14 cents 83 par livre. (Le cent vaut 5 centimes ou 1 sou pour la commodité de la comparaison.) La valeur moyenne du cuivre au cours du trimestre écoulé a été de 15 cents 15 par livre. Le bénéfice apparent provient de la différence entre 14.83 et 15.15, soit 0.32 d'un cent par livre. Si l'on multiplie cette différence par le nombre de livres de cuivre produites pendant le dernier trimestre, on obtient un profit net de $ 39,273.18 (200,000 francs environ) qui est le chiffre indiqué dans le bilan comme représentant le bénéfice du travail des moulins.

Mais comment se fait-il que les moulins puissent donner des bénéfices, lorsque les autres branches de l'entreprise ont tout mis en œuvre pour rompre l'équilibre et accuser une balance déficitaire ? La question est d'autant plus difficile à résoudre que dans aucun bilan trimestriel on n'avait jusqu'à ce jour crédité de bénéfice spécial le chapitre des opérations effectuées par les moulins. Le profit qu'on met en vedette, divisé par le nombre de tonnes de minerai traité — ou soi-disant tel — fait apparaître un profit *d'environ 4 cents par tonne, soit 20 centimes.*

Ce qu'il y a de plus remarquable dans ce bilan, c'est que le métal semble avoir été récupéré sur une base de 14 livres de cuivre par tonne de minerai traité, soit environ 68 0/0 de la teneur du minerai, et cela en face d'une moyenne de moins de 60 0/0 obtenue antérieurement, même dans les conditions les plus favorables. Ce progrès, qui apparaît d'ailleurs comme absolument hors de rapport avec les conditions habituelles, disparaît lorsqu'on se prend à considérer que près de 1,300,000 tonnes de minerai ont été, en réalité, traitées au cours du trimestre, soit près de 30 0/0 de plus que le chiffre donné dans le bilan. La différence est représentée par ce que la direction appelle l'excès de teneur du minerai en eau, par suite des conditions atmosphériques éminemment défavorables. On ne pourra toutefois s'empêcher de penser que si cet excès de tonnage n'avait pas été mis en ligne de compte dans le but de permettre à la direction de faire valoir un progrès dans la proportion de métal récupéré, le bénéfice serait *inférieur à 4 cents par tonne.*

Une autre conséquence malheureuse, due aux circonstances climatériques défavorables et au froid, semble avoir été la suivante : il a fallu faire passer sous les pilons jusqu'à 50,000 tonnes par jour afin de venir à bout de la résistance opiniâtre offerte par le minerai congelé, alors qu'il est reconnu que les minerais de la *Utah*, à la température ordinaire, sont absolument friables et faciles à traiter. Selon les dires du directeur Jackling, pour obtenir un pourcentage de métal récupéré par le travail des moulins dans des conditions vraiment économiques, il faut s'attacher à le déterminer purement et simplement par le nombre de tonnes de minerai qui peut être engouffré dans les moulins. Il est donc à supposer que lorsque les conditions climatériques se seront améliorées, il sera nécessaire de relever le nombre de tonnes broyées par les moulins pour le mettre en rapport avec celui de la section des pilons. L'augmentation ainsi obtenue n'aura lieu que par temps favorable et on se réservera de faire donner aux pilons, dont le nombre sera augmenté, leur effort maximum lorsqu'il s'agira d'assurer à l'établissement une quantité suffisante de matière traitable aux époques où le minerai sera rendu plus résistant par suite de la gelée et du froid.

Voici encore quelques points sur lesquels une lecture attentive et réfléchie du bilan ne manquera pas d'attirer l'attention:

Pourquoi la Compagnie a-t-elle suspendu le travail alors que la direction savait pertinemment que cela entrainerait non seulement une perte immédiate d'argent, mais encore celle de plus d'un million de tonnes ?

Et si ce que le directeur Jackling a dit le mois dernier est l'expression de la vérité, c'est-à-dire qu'il faudrait encore deux ou trois mois pour revenir aux conditions normales, voulant faire par cela même allusion aux événements qui se sont succédé depuis le commencement d'octobre dernier, pourquoi le travail continue-t-il à l'heure actuelle ?

Il n'y a, en réalité, aucune excuse à la manière de procéder à la fois dispendieuse et ruineuse, qui prévaut à l'heure actuelle au sein de la *Utah Copper*, et cela depuis cinq mois, ou pour le point de vue spécial qui nous occupe, et pour mieux dire, depuis le début. On pourrait cependant trouver cette excuse dans la volonté très nette d'éviter le plus longtemps possible de rendre des comptes.

La situation est désespérée. Il semble bien qu'il n'y ait pour la *Utah Copper* aucune échappatoire désormais, aucun moyen d'éviter l'orage qui se prépare et dont les nuages menacants s'accumulent de plus en plus. Cette affaire s'était elle-même définie comme devant être « la merveille du siècle ». La direction se présentait comme la quintessence de la perfection et les ingénieurs n'étaient rien moins que les premiers du monde. Les méthodes de sondage et de traitement du minerai avaient été célébrés comme le dernier mot du savoir humain et de la science appliquée. Le succès de nombreuses autres entreprises colossales autant que gigantesques, que la direction avait patronnées, les résultats mirobolants qu'elles ne devaient pas manquer d'amener, avaient été proclamés et annoncés comme devant former la vigueur et l'excellence de la *Utah Copper.*

Si l'on voulait représenter d'une manière concrète et frappante le chef-d'œuvre réalisé par ces cerveaux d'élite, par ces hommes géniaux, par leur habileté professionnelle, tant au point de vue des opérations minières que financières, il faudrait se représenter une pyramide renversée dont la *Utah Copper* constituerait la base, et construite avec des blocs énormes de béton formés de quantités disproportionnées de sable, de ciment, de gravier brut et *d'eau*, de cette *fameuse eau* dont on nous a tant rebattu les oreilles. Et on doit alors se demander comment cette pyramide pourra tenir debout ?

Experience in the Use of Water Power

By C. M. MYRICK.*

The following notes are submitted in the belief that they may interest some of the many owners of small water power plants, so generally used in mining work throughout the west.

A small and somewhat primitive mill was taken over by a leasing company, and a 10-stamp battery was installed. Originally, power had been furnished by a Pelton wheel; but since the supply of water depended on the rate at which snow was melting on the mountains, a steam plant had been added to help out during cold spells. This auxiliary plant was anticipated and expensive to operate, and, soon after starting up the remodled mill, it broke down completely; so that it became necessary to get all the power possible out of the Pelton wheel, with its ever-varying water supply.

The pipe line, about a quarter of a mile long, was made up of assorted sizes, from 7 to 11 inches in diameter; and, since it was buried deep under snow, there were no data from which to calculate the theoretical size of the nozzle. The stream being at this time at a low stage, it was important to make the most efficient use of the available water. This was done by using a nozzle large enough to pass the whole supply—taking care, however, to limit the size so as not to lower the water level in the tank at the head of the pipe line.

As the weather became warmer, the nozzles were gradually enlarged to meet the increasing volume of water; but a point was finally reached where further enlargement only gave decreased power. Evidently the loss from friction had more than balanced the gain from the increased flow through the pipe. However, the area of nozzle that developed the maximum power from the pipe line had been found. This was used; and the surplus water was allowed to run to waste at the head of the line.

All this experimenting necessitated the trial of nozzles of many different sizes; and, since these were not on hand, they were improvised as needed. Fig. 1 shows the quick and easy way in which this was done. A hole, 0.25 in. deep and of just the diameter of the outer rim of a cast iron nozzle that had been found too large, was bored into a plank. Then, using a bit of the size desired for the new nozzle, the hole was continued through the plank. A tapering wooden plug, 8 or 10 ins. long, was made to fit into this hole. The cast nozzle was forced into the shallow cut in the plank, the inner plug put in place, and the space between plug and nozzle filled with babbitt metal. The wooden plug being removed left a nozzle of the desired diameter. When this particular size was no longer needed, the babbitt bushing was easily removed by heating.

To determine the relative power furnished by the different nozzles, it was only necessary to count the number of drops of the stamps—a method which may seem somewhat crude, but which certainly showed the effective work being done.

In order to get a record of the pressure under the various conditions, the pipe was tapped close to the nozzle, and a steam gauge, taken from the boiler, was attached. The notebook containing a memorandum of these tests was destroyed in the great fire at San Francisco; but the general facts are: that, with the valve closed, the static pressure in the pipe was 60 lbs. per sq. in.; that, no matter how much water was available, it was harmful to use a nozzle larger than 2⅜ ins.; and that even a change of 1-16 in., either way, caused a perceptible slowing down of the wheel.

Discharging through this 2⅜-in. nozzle, the pressure stood at 40 lbs.; or, in general terms, water from this pipe line was yielding its maximum power when one-third of the head was lost in overcoming pipe resistances. Subsequent consultation of authorities showed that this agreed very well with the results obtained from the theoretical treatment of such problems.

Care was taken during the trial to lag up the pulleys, so that the circumferential speed of the water wheel approximated to one-half the velocity of discharge from the nozzle, calculated from the effective head. It was noted, however, that a small variation was not important.

Incidentally, these experiments demonstrated that there was a very considerable waste of power, if the cam faces were not kept properly greased; and that this loss occurred long before the cams were dry enough to throw sparks. On the other hand, there was no necessity of excesive lubrication, incurring the risk of having grease thrown on the amalgamating plates.

*Transactions of the American Institute of Mining Engineers.

FORMATION AND GROWTH OF DISSEMINATED COPPER DEPOSITS

By JAMES O. CLIFFORD.

The great importance of the low grade disseminated copper deposits of the United States is best illustrated from the fact that at present considerably more than half of the total copper metal output of our mines is won from the ores mined therefrom. The failure to find additional bonanza mines during the past decade clearly indicates that our future supply of tht red metal will doubtless be derived largely from the so-called porphyries.

Generally a disseminated copper deposit is understood to be a large body of low grade ore, ranging from one to three per cent copper per ton, which, under the most satisfactory economic conditions, can be operated to a profit. The economic phase is all important. This is best illustrated from the fact that, contrary to many statements published during the past year to the effect that copper could be produced from the "porphyries" at a cost of less than seven cents per pound of refined metal, the general average production cost ranges from 10.5 cents to 14.9 cents per pound. It will be noted, therefore, that there are several of the porphyries that could not be operated to a profit on an average market price of 13 cents per pound copper. It should be considered in this connection that there are numerous large undeveloped disseminated copper deposits in various parts of the world which are, in point of prospective ore tonnages and general average copper content per ton, far superior to our present largest "porphyries." These last mentioned properties should, in due time enter the list of producers under most favorable circumstances.

Geologically the disseminated copper deposits consist of a large mass of mineralized rock material resulting from the general impregnation and replacement of large volumes of rock by cupriferous pyrite. The several important developed properties present many interesting features in connection with the mode of ore deposition, and, while they are analagous in a general way, they are widely different in specific relation. However, it is the object of this paper merely to outline the more important phases of the situation, without calling especial attention to any individual property, only as incident to the presentation of criteria.

ESSENTIAL CONDITIONS IN FORMATION OF OREBODIES.

Two conditions seem to be particularly essential to the formation of extensive bodies of disseminated orebodies: First the presence of extensive areas of sedimentaries and, secondly, the contact metamorphism thereof through the agency of magmatic intrusions. Both the sediments and the intrusive magmas of individual properties wherein commercial ore deposits occur are of widely different character. There is, or rather, there does not seem to be, a particular type of intrusive necessary to the primarly mineralization of the district wherein the disseminated deposits are found. These conditions vary in different parts of the world. It is assumed, that the majority of the disseminated orebodies already developed owe their origin to intrusives represented mainly by rocks ranging from granites to monzonites in composition. This is true of many deposits, but not of all.

The present tendency is to regard the igneous rocks, either directly or indirectly, as the ultimate source of the metals. Two hypotheses advanced covering the primary ore genesis are (a), the theory of the inclusion of metallic minerals as accessories in the igneous rocks themselves, and the subsequent extraction and segregation of the ore materials through weathering processes and (b), the production of metalliferous bodies in connection with rock masses in a metallic state, either through magmatic secretion or by the expulsion of the volatile compounds of the metals during the process of magma cooling.

Ore segregation from already solidified igneous rock masses involves processes and conditions very different from those obtaining in the case of cooling rock magma wherein the metallic compounds are being expelled in volatile form and collect around the margins of the slowly-cooling molten mass. The metallic content of unweathered igneous rocks are completely locked up in them, and they may be released through weathering, or through metamorphic change below ground-water level. Where not exposed to weathering the contribution of metals to the formation of orebodies is small, but through exposure to the elements the quantity of metals liberated by the degradation of the rock mass, in the aggregate is great.

MAGMATIC ORIGIN OF METALS.

In considering the magmatic origin of metals, and the association of ore deposits with cooled magmas, investigations have resulted in the determination of the presence of ore-forming materials as a general diffusion through molten magmas, in which minerals containing the important commercial metals have been found present in igneous rocks which apparently had solidified from a molten state.

Further, it has been noted that, under the high temperature and great pressure obtaining at the time of intrusion, the mineral compounds doubtless existed in volatile form. The later cooling of the magmatic mass resulted in the expulsion of the greater part of the contained metals into the surrounding or overlying rock series, which accounts for the fact why so many metalliftrous deposits, and particularly the porphyry deposits, are found at and above the line of contact of the igneous mass and the rock series through which they break. The segregation of the dissolved metals in magmatic masses occurs through a process of differentiation during the period of cooling and later solidification of the mass.

During this process following the expulsion of the metallic content of the cooling magma, the mineral components of the mass undergo a change resulting in the first instance in the formation and segregation of the accessory rock constituents which, together with a small percentage of the original metallic content of the magma, crytallize out.

PROCESS OF DIFFERENTIATION.

The differentiation of ores from magmas is especially interesting, though the attention the subject merits has not been given it. In the instance of metallic differentiation, represented by the occurrence of extensive bodies of iron, lead, zinc, in local profound development along the marginal facies of the original magmatic intrusion, seems to depend entirely upon a composite of static, cooling, and crystalline differentiation. This seems to be true particularly in the case of the porphyry coppers where an almost perfect segregation of the orebodies of metals other than copper occurs. The best explanation of the situation seems

to be that the magmatic minerals, exceptionally rich in metallic sulphides, is subjected to static differentiation in the lower depths of the earth, followed by further differentiation through cooling during ascent towards the surface of the earth, and finally the crystalline differentiation which results in the final segregation and concentration of the orebodies along the margin of the cooling magma.

The final concentration of metallic sulphides appears oftentimes as a large distinct orebody (as in the instance of the Hanover-Santa Rita deposits of iron and zinc ores, and the extensive zinc blende deposits in the Butte district) of high-grade ore. In many instances, however, there apparently has not been a completion of the processes of segregation and concentration, due to the too rapid solidifying of the magma, in which event the product of concentration is relatively small.

An example of this latter state occurs northwest of the Hanover district, New Mexico, where the original mineralization consisting of iron, copper, zinc, and lead sulphides occur in the limestone series overlying the quartz-monzonite porphyry which is considered to be the source of the mineralization of that area extending through from Santa Rita northwesterly into the Copper Flat district, a distance of several miles in length, and two miles in width.

Similar occurences have been noted elsewhere but the district mentioned is taken as an example in view of the fact that it presents a combination of both circumstances wherein there has been a completion of the process of concentration of the original metallic sulphides of the intrusive magma, as well as a presentation of conditions relating to a state of the original unaltered igneous rock at its point of contact with the overlying sediments.

MAGMATIC SEGREGATION.

Among other considerations governing the processes and the conditions attending the segregation of the several ore-forming minerals incident to igneous intrusions are the resultant lines of weakness developed in the earth's crust when, through mountain-making movements, the molten magma is forced upward and the rocks which it traverses are more or less extensively displaced as well as fractured and brecciated. Further, the cooling of the molten body of magma results in shrinkage of the mass and produces cracks and crevices both in the hardened margins and oftentimes in the overlying rock series.

The result of this condition is that gases from the interior are extruded into the crevices both of the solidified margins of the igneous mass and of the surrounding rocks into which the intrusion has taken place resulting in the formation of extensive deposits of high grade ore in the form of fissures within the igneous rock itself, and continuing outwardly into the overlying sediments (where present) and producing enriched ore zones both in the form of lenses or chambers occasioned by replacement of the limestone, and as areas of concentration along the planes of contact.

In the case of the disseminated replacement copper deposits slow cooling of the intrusive mass is preferable as it results in the more uniform fracturing of the igneous rock, and consequently a more diffuse mineralization of the overlying rock series. Acid intrusives seem to result in a more thorough and uniform fracturing and mineralization of the rocks, whereas basic istrusives generally develop main fissures resulting in the localization of the minerals as vein deposits rather than a dissemination of the metals. In this connection while the factor of brittleness based upon the relative percentage content of silica and iron is in part the determining factor, other equally important features are the physical conditions accompanying the intrusion which doubtless play the most important role insofar as the question of localization or dissemination of the primary ores are concerned.

Of particular importance is the determination of the zones of greatest strains and fracturing as these factors govern the channels of circulation of the mineral-bearing solutions and the location of the ore deposits. Excessive strains produce fault-vein systems in addition to minor fracturing resulting in a combination of governing fissures and associated contact-deposits of disseminated ores.

FORMATION OF DISSEMINATED DEPOSITS.

From what has been outlined the general conditions governing the intrusion of magmas into the overlying rocks with attendant mineralization either as a uniform dissemination of the contact zones, or as a localization of ore deposits due to the development of main fissures, the subject of the formation of ores bodies of the disseminated porphyry type now can be taken up.

The fulfilment of two conditions seem to have been necessary during the process of primary mineralization; the intrusion of a magma rich in metallic sulphides into overlying sediments, resulting in the mineralization of the latter; the complete or fractional fissuring of the igneous rock through slow cooling with attendant expulsion of metallic salts. Dependent upon specific physical conditions, and chemical components of the intrusive, the result of primary mineralization was either the complete dissemination of the primary metallic sulphides into the overlying rocks, or the localization of ore bodies in main fissures cutting both the sediments and the igneous rock. Throughout the sedimentary series seem to have played as important a part in the formation of the orebodies as the original mineral-bearing intrusive. From a general review of the geological conditions surrounding the so-called "porphyry" deposits it is quite apparent that, while the general view seems to follow the theory of uniform dissemination, the evidence afforded points more to a composite of localised zones of enrichment in which the dissemination of the primary mineralization was of minor importance. In other words the concentration of the metallic salts extruded from the cooling magma quite generally resulted in the formation of replacement and contact-metamorphic deposits in the superincumbent sediments, and as vein deposits in the igneous rock itself. The dissemination of the contact zones was apparently of secondary importance. However, considered either from the point of view, either of localized or disseminated area following the original mineralization, the ultimate result, in so far as the formation of deposits of secondary enrichment are concerned, would have been the same, but the former condition of a localization of orebodies rightly should be given more consideration than it has heretofore been accorded.

SECONDARY SULPHIDE ENRICHMENT.

In discussing the subject of secondary sulphide enrichment as applied to the disseminated replacement copper deposits the following order will be observed: (1), General Nature of Process; (2), Structural Relations Governing Deposition; (3), Climatic and Topographic Conditions; (4), Physical and Chemical Processes; (5), Types of Deposits.

The reader can assume the original mineralization resulting from the igneous rock to have resulted in either the formation of localized deposits of cupriferous pyrite, or as a uniform dissemination of the mineral in the form of a contact-metamorphic deposit, or as a mineral-bearing volcanic extrusion. The ultimate result of the disintegration of the rock followed by the oxidation, transportation, and later precipitation of the metallic content will be the same.

The primary result necessary for the commencement of secondary enrichment is that the metal-bearing rock mass be subjected to weathering processes, in-

volving the degradation of the rock material, the oxidation, transportation, and subsequent precipitation of the metallic content. Further, there must be well-defined channels of movement for the metal-bearing solutions to insure the uniform distribution necessary to the formation of ore deposits. If the underlying rock mass affords a condition of uniform fracturing, with a minimum of large fissures and fault planes, the result will be the formation of a disseminated ore body of a comparatively uniform copper content; if the area of brecciation, or fracturing, is limited in extent, and the channels for the transportation of the metallic salts in solution are confined mainly to large fissures, the result will be the formation of enriched zones of ore, or a localization due to secondary enrichment. Types representative of comparatively uniform dissemination, localization, and a composite of both types of orebodies are common.

NATURAL RESULTS OF PROCESS.

Generally the process of secondary enrichment develops zones of oxidation solution, and precipitation, in addition to the original upper area of the igneous intrusion, or zone of primary minerals, occuring in descending scale in the order named. There is a gradual merging of each respective zone into the one following, so that the line of demarkation between the respective zones is difficult to determine. In the zone of oxidation there often appears an iron cap, composed of hematite or limonite. Residual gold as a concentration product, and often silver salts are found therein. Immediately below this surface zone of oxidation there occurs a zone of leached material containing appreciable quantities of lean pyrite ores, and often gold and silver in a lesser degree of concentration than in the preceding zone.

Directly underlying the zone of leached material which may be two hundred or more feet in thickness, is the zone of oxide enrichment. This latter zone represents the occurence of the more thoroughly oxidized ores, native elements oxides, carbonates, sulphates, and silicates. Following this zone is that of the secondary sulphides. Insofar as the formation of commercial orebodies of the disseminated replacement type are concerned, this zone is of especial importance. The thickness of this zone varies, and is dependent, as are all the others upon the rate of erosion and the quantity of copper minerals which have been leached from the overlying strata and therein concentrated. There is no definite depth to which this zone extends, and by no means is it dependent upon the upper limit of water level. The zone of primary sulphides occurs immediately under the zone of secondary enrichment, and is of variable thickness.

The depth to which secondary enrichment has penetrated is dependent upon many conditions. Of these one of the most important is the rate of erosion of the upper or original orebodies, and the depth of the brecciated or fissured zone of the primary ore area. In this connection however, the depth to which secondary enrichment has penetrated quite generally is taken as the point of limit of ores of commercial grade, although evidences of enrichment might occur at much greater depths.

It should be considered, in relation to the process of secondary enrichment, that the principal governing factor is the rate of erosion referred to the original copper mineral content of the overlying orebodies, relatively to the copper content of the ores in the primary zone. Contrary to the general supposition that enrichment ceases at ground water level, it is pertinent to observe, that while surface water partly is responsible for the occurence of secondary enrichment of ore deposits, and erosion of the area containing the original mineralization exposed to weathering can be thoroughly effected only through the agency thereof. The predominant factors are the physical and chemical characteristics of the rock series and mineral-bearing solutions relatively to the intensity of circulation regardless of any definite water level.

In the southwestern porphyry areas the climatic conditions are semi-arid, and the rate of erosion comparatively slow. Under present conditions, therefore, the time required for the concentration of the metallic salts of the upper areas would be lengthy so that, unless we assume the conditions as outlined in the preceding paragraph, we might expect the occurrence of orebodies representative only of the original mineralization; excepting, of course, the occurrence of high grade ore-deposits formed in the manner hereinbefore indicated.

In reference to the original volume of metallic salts contained in the contact-metamorphic, fissure, or replacement zones of the enrichment, little can be said. It is certain, however, that the quantity of such metallic salts returned to the intrusive as sources of secondary enrichment represents but a very small percentage of the original volume extruded. That is the peculiar circumstance which makes it almost certain that erosion of the overlying rock series was intensive. Should we assume a condition wherein the general average copper content of the overlying rocks was the same as that at present indicated in the primary ore zone, the percentage content of the metallic salts returned would be trivial. In short, assuming the general average content of the primary ore zone (the igneous rock responsible for the mineralization) to be 0.3 to 0.7 per cent copper, the volume of material overlying the intrusive to contain similar percentages then allowing an equal thickness for the mineralized areas of both rock series, the probable return of metallic salts for the purpose of secondary enrichment would not exceed five per cent. of the total. Therefore, for the formation of a disseminated deposit averaging two per cent copper per ton, there would be required an area of mineralization ground of the same general copper content as the primary ore zone equivalent to twenty times the area of the zone of secondary enrichment.

This outline of the relative volumes required for the formation of commercial deposits of disseminated ores is subject to further consideration. Under the law of progressive erosive action it must be considered that, following each successive stage of concentration of minerals through the several stages of leaching, the average content of the next lower horizon is increased, and in turn exposed to weathering, and it follows that each successive exposure of enriched ore undergoes serious mineral losses, so that, in finality, the total quantity of copper mineral required in the process of enrichment of the orebody is considerably greater than the estimate of twenty volumes above mentioned.

CHICKENS IN SMELTER FUMES

A member of the State Legislature from down state was spending the winter with a sister near Murray, her chickens were of great interest to him, as they were kept in city houses with never a glance at the sky.

"Why don't you let them run free," he asked her one day.

"If I did I wouldn't have any by Thursday evening; they eat too much smelter smoke that scums the ground over when it settles. O no, you can't see it on the ground, neither can those Rhode Island Reds, but they go about picking up everything that's loose in the way of eatables, and then they get diarrhoea, and then the ax when I feel real humane towards them, for they cannot get well while running in an open lot."

And then she revealed to the legislator a few of the tricks of the chicken trade. Her records showed that more than half her chickens died when left in open lots to feed; when fed under a shelter, but left to scratch and roam in the open, many still died, but the loss was appreciably less; she soon found that by raising them on the apartment house, or

city's "flat" system, where no hen can get to the uncovered ground where the smelter fumes settle she never lost a head from that kind of sickness.

"O, yes," she told him, "I did lose eight or ten one week from that trouble since they were boxed up, but one day during that time I caught a hen drinking from a puddle through a crack in her box and that settled it in my mind; that puddle was made by the rain water washing down from the roof, and the roof was coated with poison." And the few folks that do raise chickens in the poison belt are said to have had similar experiences with their chicken growing.

Another Magnetic Prospector

That gold, silver and other rare minerals can now be located by the attraction of the magnetic needle is the startling announcement in the Deadwood Pioneer-Times, says the Engineering and Mining Review. No, the Stauffer brothers have not moved their "Spanish needle" plant to the Black Hills. Local talent has been drawn upon. The inventor, accordig to the Deadwood paper, is C. D. Berg, of Lead, S. D., and he has perfected an instrument, the "forceful electromagnetic oscillations or vibrations of which over an ore deposit are simply wonderful." The inventor reports that he was first confused by the attraction of many different minerals so that he could not distinguish one from another but subsequently learned how to discern the different kinds of minerals "even to three or more different kinds of minerals in one ore." A demonstration of the instrument was given by the inventor, "whose body constitutes a great part of the instrument."

We quote the observations of the Pioneer-Times: "Picking up his instrument, which consists of a battery suspended to an electric cord, the other end of which cord is provided with a metallic handle, or rather a dry-cell battery with a handle, which he firmly held in his hand, Mr. Berg placed it over a piece of gold-bearing ore, and immediately the instrument began to oscillate over the ore. He then told us to watch him closely, and proceeded to place a small bit of some material between his teeth. While holding this material between his teeth and being careful to keep his lips from coming in contact with it, the instrument would work uninterruptedly, but the moment he closed his lips against the bit of material and the flesh part of the lips came in contact with it, the current evidently emanated from his body and was immediately cut off and his instrument ceased to work while the circuit was thus cut off."

Like many other inventions, its success seems to depend upon the constancy with which the inventor can keep his mouth open, writes a Black Hills metallurgist. Another curious feature about these wonderful devices is that they develop such affection for their inventors that they refuse to work in any other hands. It is fortunate that the inventors are of an altruistic temperament, which prevents them from going out and locating all ore deposits for themselves. Still they may not be averse to disposing of an interest in their invention to others, and we wait with bated breath the announcement that two or three more Homestakes have been located in the Black Hills.

SUBURBAN WEATHER STATIONS

—A little more than a year ago, government weather instruments were exposed at Midvale, about one hundred and fifty feet above the level of the streets of the business section of Salt Lake City, and twelve miles south; about the same time a similar weather equipment was installed on a high farm at west Granger, twelve miles southwest of Salt Lake City, and about three hundred and fifty feet above the level of Main Street and Second South street intersection. The thermometers at these places are standard Weather Bureau pattern, maximum and minimum self-recording instruments, and are exposed in regulation shelters, making and equipment and an exposure almost exactly like the equipment and exposure of the official apparatus in this city.

The records for the calendar year 1912 show mean annual temperatures at Granger of 48.2 deg.; Midvale, 49.5 deg., and Salt Lake City, 50 9 deg., or a difference of 2.7 deg. between Salt Lake City, under the city and smelter smoke, and Granger, above the usual limit of the valley smelter smoke.

The effect of the city smoke combined with the smelter smoke makes this difference of temperature but the difference between Granger and Midvale is caused alone by the smelter smoke, apparently, and amounts to 1.3 deg., or just about one-half of the total influence in Salt Lake City, showing the entire lower portion of the valley to be more or less effectively smudged by smelter smoke.

In January, 1913, when city fogs and smokes were so numerous in Salt Lake City, the Salt Lake City mean temperature was 26.9 deg.; Midvale, 24.6 deg.; and Granger, 22 6 deg. The difference between Salt Lake City and Granger is 4.3 deg. for this foggy month, and the difference between Granger and Midvale is just 2.0 deg., or nearly one-half the total difference shown between Salt Lake City and Granger.

Therefore, it will be seen that while the City of Salt Lake has learned the lesson of smudging very well, from the Utah Fruit Growers, the valley, also has done about one-half as well, though it covers twenty times the area and has only two or three smoke stacks (smelters) to look after its interests.

FREEZING OF ROCK DRILLS

Freezing at the exhaust of rock drills, due to the sudden expansion of compressed air, and the consequent deposition of entrained moisture, is sometimes a cause of serious delay in winter drilling. Numerous expedients are available to overcome this difficulty. The most satisfactory is to place a water trap near the drills at a low point in the air line, in which the water carried in the air may be condensed and the air thus dried. Reheating of the air is also valuable; and in addition, secures an increase in efficency. Another method is to provide the drills with valves having a larger clearance. Valves for use with steam are often furnished with air drills because they are ground with a smaller clearance in the valve chest than the regular air valve, and are, of course, more economical. When freezing is threatened, air valves, with a clearance three or four times greater, should always be substituted. When reheaters and water traps cannot be used, cup grease has been found effective. The grease is fed into the machine about a cubic inch at a time through the throttle, and one application per shift is usually sufficient to prevent trouble from freezing. The grease should be about the thickness of heavy vaseline. Wood alcohol has also been tried but its effect is not so lasting as that of the grease. New drills are more susceptible to freezing than those that have been in use a week or two and are well limbered up.

The Evening Telegram says it understands—again—that the Utah Copper is dickering for Ohio Copper and Heinze's Mascotte tunnel. The hitch seems to be that Heinze don't care to trade Mascotte tunnel stock for Utah Copper shares; he wants the Utah company to sell the stock and give him the money. And that would be all right "if we could sell the stock."

Copper mines near Huelva, in Spain, where the Rio Tinto is situated, employ about 10,000 laborers, and in 1911 the output was over 1,000,000 tons of pyrite and 17,657 tons of copper ingots.

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According to a local paper Samuel Newhouse was interviewed by the Boston Post the other day. After designating him as "the father of copper mining" in this state, the reporter made him say, among other things: "Our state is young as far as development of resources goes. When I went there fifteen years ago, and said that the properties carried paying quantities of copper, I had but little support, yet I saw the great Bingham camp grow from a production of 150 tons of ore per day to 20,000 tons a day."

When Mr. Newhouse went into Bingham it was for the purpose of exploiting the Highland Boy as a gold mine. He organized a company and built a big leaching mill on the ground and then, to his dismay, discovered that, on account of the copper in the ore, whatever gold the rock contained could not be recovered at a profit. That was his first intimation that Bingham contained any copper ore and he undoubtedly would have concealed the fact if he could; and he did as long as possible. Mr. Newhouse's familiarity with the commercial handling of copper ores is described in another article in this impression of Mines and Methods.

Inside and Outside of Alaska Gold Mines Deal

We are indebted to the Boston News Bureau of the tenth instant for a statement which seems to shed some light on the inside, as well as the outside, manipulations of the shares of the Alaska Gold Mines Company.

It will be remembered that, in August of last year, a circular letter was sent out by Hayden, Stone & Company to its large clientele of investors and the public to the effect that:

> There will be issued at the present time 614,700 shares and the company will hold in its treasury $1,790,000 Alaska Gastineau bonds out of a total issue of $3,500,000, being a majority, and $9,801,000, par value, Alaska Gastineau Mining Company stock, being about eighty per cent of the total capital of $12,000,000. There will be placed in the treasury of the Alaska Gastineau Company $1,250,000, and, in addition, in the treasury of the Alaska Gold Mines Company (the holding company) the further sum of $3,250,000, or a total of $4,500,000 in all.
>
> The balance of the authorized capital of 750,000 shares of the Alaska Gold Mines Company unissued, amounting to 134,300 shares, will be reserved for the general purpose of the company and to acquire, if it can be done on reasonable terms, the outstanding $1,710,000 of bonds of the Alaska Gastineau Mining Company, and the $2,199,000 of the capital stock of the Alaska Gastineau Mining Company.

Pursuant to the foregoing it was announced that the books would be opened for the receipt of subscriptions for the shares to August 28th. Thereupon, subscriptions were showered upon the promoters in such number that within a few days it was announced that subscriptions had exceeded the possible number of shares to be issued ten times over. Whereupon the manipulators of the market began with feverish energy by offering for sale subscription rights, the purchase of which involved the payment of the subscription price and then a premium which these rights were made to appear to bring in the market. By this process before the date for closing the books against subscription had arrived the price had been washed up to $9.25 per share; that is, the purchaser was required to pay $4.25 as a premium for the right to buy the shares at the initial subscription price of $5.00, to which, of course, would be added in due time $5.00 to complete the purchase.

Upon the close of the subscription on the date stated, it appears that the issue had not only been over-subscribed ten times, but also had been oversold to like extent, and bought back in the process of washing up by the insiders at the advanced price.

Of course, it was expected that the public would come in and participate in the purchase of rights at the inflated price, and thus not only afford the original subscribers the usual and expected profits and quick returns, but also, for the holdings of the insiders which, as stated in a circular letter constituted "a large majority of the entire capital stock." But the public failed to respond and the consternation that ensued among those festive promoters was intense; in fact, indescribable. But they were equal to the emergency, and it was therefore announced broadcast that the confusion created by the excessive over-subscription had rendered an equable distribution of shares impossible.

At first dire threats were sent out that parties who had sold "short;" that is, those who had sold their subscription rights back to the promoters, were informed that they would be called upon at once to make delivery, and not being in position to enforce the issue of the shares to themselves of course a great number of wealthy gentlemen with speculative proclivities would be "put in a hole." But, upon further deliberation, the fact apparently dawned upon the avengers that they had prepared a very deep cavern between themselves and the would be legitimate vendors of shares which had been bargained to them and which they now proposed to refuse to deliver Thereupon the whole deal was declared off and the subscription list metaphorically burned.

After a week or more of apparent deliberation, and without previous notice to the public, offerings of the shares upon which it was purported $5 had been paid was inaugurated upon the market. Having denied all subscribers the right to shares under the subscription as before indicated it is difficult to understand just how those share offerings became part paid.

We have seen how that, as set forth in the Hayden, Stone & Co., circular, a large majority of the stock had been alloted to the group of gentlemen who constitute the board of directors, and who had already acquired the properties, which necessarily implies that these shares were thereby fully paid; so that, the remainder, whatever that may have been, and which had been offered to the public and later withdrawn as before stated, was alone subject to sale under conditions originally set forth. Now, as to whether the shares that were originally offered to the public were sufficient in number to produce $4,500,000, the amount agreed to have been placed in the treasuries of the two companies, will depend the question as to whether the majority holders would be required to contribute any amount in cash at all to make up an existing deficit The Boston News Bureau says:

> The Boston Stock Exchange has admitted to quotation on the unlisted sheet 193,279 full paid shares, and stock receipts for 517,295 half paid shares of the Alaska Gold Mines Co.
>
> The authorized capital stock is 750,000 shares. There are 39,426 shares held under option at par until July 1, 1913.
>
> The company owns $3,184,000 of a total of authorized issue of $3,500,000 first mortgage bonds and $10,095,140 out of a total authorized issue of $12,000,000 capital stock of the Alaska Gastineau Co.

From which it will be seen that the 135,300 shares which were "reserved" for general purposes of the company and to take up certain outstanding interests, etc., have been returned, which implies that no further interests are to be acquired.

This places the Alaska Gold Mines Company in possession of approximately five-sixths of the capital stock of the Alaska Gastineau Company, upon which interest the entire capital stock of the Alaska Gold Mines Company is based.

Now it appears that 193,279 shares have been alloted as fully paid stock to the gentlemen who compose the directorate and hold a large control as above indicated. This conclusion necessarily follows from the fact that no suggestion appears anywhere of any of the shares having been otherwise fully paid in cash. In addition to the allotment it appears that 517,295 half-paid shares have been disposed of to somebody—presumably the public—by payment in cash of one-half the par value, or $5 per share, leaving of the entire issue only 39,426 shares undisposed of, but which latter have been optioned to some favored interest. From all of which it will be seen that something more than 200,000 of the half-paid shares which would be necessary, including the fully paid allotment, to constitute a large control are evidently the property of the directorate; so that, assuming a final disposition of these shares by the payment of the balance of $5 the directorate will then own, without apparent cost, 193,279 shares, or a little less than two-sevenths of the stock of the corporation Therefore it is apparent that the directorate will be entitled to take down in cash all sums received for the remainder of their original holdings which may be in excess of $4,500,000, the amount which it is understood they will be required to place in the treasuries of the two companies. Thus it will be seen that the 517,295 shares fully paid stock will return $672,950 in excess of the treasury requirements. This sum, together with the value of the 193,279 fully paid shares if sold only at par will afford the very comfortable profit of $2,605,740.

Now, if we could assume that the activity in Alaska Gold Mines shares, whereby half-paid shares were carried up to about $16. in price, represented actual transactions in the stock, perhaps a couple of millions more profit might be added to the sum above mentioned. And yet, we are told, the deal is only in its infancy.

Possibly it might be assumed that the fully paid shares represented corresponding cash investments in the acquirement of the five-sixths interest in the title to the property which now seems to be lodged in the Alaska Gold Mines Company. But that would be a mistake, because it was stated at the outset that the sum of $4,500,000 which was to be derived from the sale of capital stock was to be applied "to the purchase of a control in the Alaska Gastineau Mining Company, and to construct a mill and finance the development of the property." Some indication of the price to be paid for the control may, however, reasonably be inferred from the fact that $1,250,000 of the gross fund is to be placed in the treasury of the Alaska Gastineau Mining Co., presumably for the benefit of the vendors.

Of course, the 39,426 shares optioned as before stated, whether sold or unsold, become naturally an increment of the profit of the gentlemen who hold large control as before indicated.

From the foregoing it is quite evident that when each of the participants becomes possessed of his share of the profits thus far accumulated it will not be long till the new issue of stock, frequently alluded to by the promoters, and which it is said would not be put out at less than $25 per share, will soon become a reality.

Therefore, it seems pertinent to observe in conclusion that the reputed withdrawal of stock from sale to original subscribers became operative to nine-tenths of the subscribers who were excluded, the remaining favored one-tenth being selected from the mass of subscribers with a view to their amenability to requirements which prohibited them from dealing in rights thus secured until full payment of the price had been made; and even then until the price could be washed up to a point at which the shares would become most attractive to the public—which, of course, is always the top notch.

UTAH COPPER'S ANNUAL REPORT

The issuance on April 26th, 1913, of the Utah Copper Company's annual report to stockholders for the year ended December 31st, 1912, was not significant of any change for the better in point of actually enlightening stockholders as to the financial and physical condition of the company's affairs. To the contrary, a review of the report elicits the information that, if anything, the deceptive practice of withholding facts which should be known to investors in the company's securities is, relatively to all preceding reports, more pronounced.

Brief outlines of the company's operations for the year are presented by the president and the general manager respectively; also, the usual series of statements (termed "Exhibits" in the report), purporting to clearly portray operating conditions at the properties in detail. While in the reports mentioned there seems to be, to the cursory reader, an apparent effort on the part of the management to present facts, yet such a condition actually does not obtain. Briefly, too much space is taken up in statements relative to ore tonnages developed at the mines; low operating costs at both mines and mills, resulting in a low production cost per pound copper that absolutely is incorrect, and other similar statements, all of which when subjected to analysis fail of substantiation.

In reference to the increase in developed ore reserves for the year ended December 31, 1912, the management has changed its method of computing available ore reserves over that obtaining during the previous year. For example, in the 1911 annual report an attempt was made to classify ore reserves according to the percentage copper content of the different areas of fully or partially developed territory, at least giving a semblance to the presentation of facts. The 1912 report is wholly different in that respect.

Taking the matter up in detail it is observed that on January 1, 1912, the company claimed ore developed as follows:

FULLY DEVELOPED.

62,040,000 tons	averaging	2.0%	Copper.
92,130,000	"	1.6%	"
75,660,000	"	1.3%	"

229,830,000 tons averaging 1.609% Copper.

PARTIALLY DEVELOPED.

71,670,000 tons averaging 1.28% Copper.

Combining the fully and partially developed ore reserves claimed, there is returned 301,500,000 tons of ore having a general average copper content of 1.532 per cent.

The manner of presenting the statement of developed ore reserves as of January 1st., 1913, is not so clearly defined in the report for obvious reasons, but is given as follows from the president's and general manager's reports:

Fully Developed Ore: 257,584,500 tons averaging 1.60% Copper.

Partially Developed Ore: 80,116,342 tons averaging 1.16% Copper.

The combined tonnages of fully and partially developed ore as stated return a total of 337,700,842 tons averaging 1.495 per cent copper, according to the management's report. Now in this connection the point to which attention is called is the fact that the total claimed tonnage, (337,700,842 tons of ore) represents the quantity of material developed since the commencement of development operations several years since. Then to determine the net tonnage remaining in the property as of January 1st., 1913, there is deducted from the total amount above given 21,200,842 tons of ore averaging 1.542 per cent copper representing the total tonnage of ore removed from the properties since beginning actual mining operations several years since. In that manner the quantity of ore reserves is reduced to 316,500,000 tons having a general average copper tenor of 1.495 per cent, representing the total available ore as of January 1st., 1913, a net increase in ore reserves over the year ended January 1st., 1912, of 15,000,000 tons.

The principal object sought in the presentation of the 15,000,000 tons of additional ore developed during the year 1912 in the manner mentioned seems to have been to evade a statement sufficiently direct to enable stockholders to understand the real value of the newly developed ore reserves. It may be of interest, therefore, to point out just why there was no distribution of ore tonnages made according to relative percentage copper content as in the instance of the 1911 report.

Assuming the correctness of the management's figures on ore reserves developed as of December 31st., 1911 and 1912, respectively, as 301,500,000 tons and 316,500,000 tons, then we may carry the matter a point further. During the year 1912 there was mined and milled on the properties 5,315,321 tons of ore averaging 1.3642 per cent copper. Therefore the actual gross increase in developed ore reserves developed during the year must have been 20,315,321 tons. Hence, if we make a strict comparison of the figures given it will be seen that the average copper tenor of the gross tonnage developed during the year, (20,315,321 tons), is 0.9271 per cent. It follows then that, allowing a deduction of 5,315,321 tons averaging 1.3642 per cent copper ore mined and milled during the year, the copper content of the net increased developed ore, (15,000,000 tons), contains an average of but 0.772 per cent copper—material that can not be consistently classed as commercial ore at the Utah Copper properties under the peculiar operating conditions obtaining thereon. Further, the addition of the net 15,000,000 tons of developed ore added to stock during 1912 has served to reduce the general average grade of the ore deposit from an average of 1.532 per cent copper for the 301,500,000 tons available January 1st., 1912, to an average of 1.495 per cent copper for the 316,500,000 tons available as of January 1st, 1913. The effect that this reduction in general average grade of developed ore will have on future operations is best reflected in the comparison of the grade of ore milled during 1911 with that milled during 1912—1.51 per cent and 1.3642 per cent, respectively.

Referring to the matter of stripping operations for the year it is noted that according to the management's statement the general average thickness of capping over the entire developed orebody has been increased from 106 feet in 1911 to 110 feet in 1912. According to the management's figures the area stripped during 1912 amounted to 11.909 acres, thereby bringing the total area completely stripped and available for steam shovel mining up to 44.529 acres. The quantity of material (capping) removed to December 31st, 1912, amounted to 17,289,725 cubic yards, equivalent to 35,910,767 tons; therefore, the actual average capping removed from the stripper area amounted to 240.7 feet in place of 110 feet, as stated by the management.

As previously stated the total tonnage of ore mined and milled, according to the company's report for 1912, was 5,351,321 tons of a general average grade of 1.3642 per cent copper. The mill production of copper in concentrates amounted to 96,175,090 pounds, equivalent to a saving of 66.32 per cent of the copper content of the ores treated, compared to a saving of 69.53 per cent during the previous year. The general average grade of concentrate produced was 20.75% copper, compared to an average of 25.62% copper for the year previously.

In connection with the cost of copper production we note that it is given at 9.024 cents per pound as compared to a cost of 7.8655 cents for the previous year, although in reference to the average mining and milling costs for the year it is noted that a decrease of 4.86 cents per ton of ore handled obtained over the cost for the preceding year. The cost of mining is given at 42.33 cents per ton ore; milling cost as 41.58 cents, and transportation cost on ore from the mines to the mills at 28.48 cents, a total of $1.1239 per ton. Smelting, refining and freight amounted to 83.422 cents per ton of ore mined. Taking these factors for the purpose of calculating the absolute direct cost of production it will be noted that:

Costs.

Mining and milling 5,315,321 tons at 83.91 cents	$ 4,460,085.85
Freight from mines to mill at 28.48 cents............	1,513,803.42
Smelting, refining and freight, at 83.422 cents..	4,424,175.34
Selling commission	154,073.34
Total	$10,552,137.95
Stripping orebody during year, 9,713,233 tons at minimum of 26.35 cents a ton	2,559,436.90
Total	$13,111,574.85

Revenue.

91,366,337 lbs. copper at 15.8391 cents	14,471,575.62
34,255.765 ozs. gold at $20.00	685,115.30
311,391.520 ozs. silver at 60.657 cents	188,880.07
Miscellaneous	382.33
Total	$15,345,953.32

Therefore, on the net production of refined copper the direct cost per pound, exclusive of stripping expense for the year only, or allowance of gold and silver credits, amounted to 11.55 cents. Allowing gold and silver credits the cost would be 10.59 cents, and by including the stripping expense for the year (as should be done) the cost per pound copper would be increased to 14.35 cents. It is plain that, even allowing the deferred payment of stripping expense as employed by the management under its system of accounting, the Utah company's production cost of copper does not fall under 10.59 cents per pound even under the most satisfactory operating conditions, and it is pertinent to observe that in view of the lower copper tenor of the ore now available for mining and milling the future production cost will be increased realtively to the 1912 figure rather than decreased as stated by the management

JACKLING'S VIEWS ON LEAD

When ex-Manager D. C. Jackling, of the Utah Copper and other companies, returned from his resignation trip to New York early in the month he was interviewed by a trusted and most competent reporter of the Salt Lake Tribune. Among the wise and otherwise things he was credited with saying was this:

"The lead and zinc industries are by some regarded with apprehension on account of the attitude of the present administration toward the tariff, but the taking off of the tariff is not going to kill or seriously cripple those industries. They are too big."

Mr. Jackling probably did not realize just how that was going to look in print; he did not seem to appreciate that such a statement might be construed as a direct slap at his friends and co-laborers, the Guggenheims. After reading it he most naturally grasped the situation and proceeded to make amends as best he could by being re-interviewed by the Herald-Republican the following morning, and the fact that the Tribune carried no correction of his statement indicates that the reporter for that paper did not misquote him. Here is the way he excused himself after having read what he said to the Tribune:

"There are very few producers of lead and zinc in the United States who could survive a complete removal of the tariff on these metals and such action would be little less than a calamity. Practically the only producers of these metals who would be able to survive would be those whose properties produce precious metals in such quantities as mean the difference between operation at a profit or at a loss. What I intended to have understood in my former statement was that I was hopeful that the final modification of the tariff would be so slight that, although it would surely be disturbing, it eventually would not interfere seriously with the mining industry of the country.'

While the latter statement takes a little of the bad taste out of the first one made—or may ease him down with the Guggenheims—it is evident that the gentleman was worried over both statements, the one on account of what he did say and the other for lack of words with which to properly excuse himself.

DEFICIT CONVERTED INTO PROFIT

According to the Utah Copper Company's first quarterly report for 1913, just issued, gross copper production was 23,884,467 pounds recovered from the treatment of 1,460,707 tons of ore having a general average copper content of 1.2495 per cent, reflecting an apparent mill extraction of 65.75 per cent.

It is noted that the general average grade of the ore treated during the first quarter of the present year is slightly higher in average copper content than was the material treated in the last quarter of 1912, which latter was 1.104 per cent per ton. However, considering the statements made by the management that there is fully developed and available for steam shovel mining some forty million tons of ore averaging in excess of 1.5 per cent copper, it is difficult to conceive why, in view of the policy of the company to treat its higher grade ores first, the grade of ore for the first quarter of this year is so low—and particularly in view of the fact that the entire developed ore reserves as of January 1st., (316,500,000 tons) were calculated to average 1.495 per cent copper. Weather conditions should by no means influence the metallic content of the ore reserves, and if the statements of the management are to be credited, the area of stripped ground available for steam shovel mining should contain ore of much higher general average copper content than has obtained during the past several months.

The report states further that "net profits for milling operations for the quarter were $1,110,346.21; other income, rents, etc., in Utah, $49,828.81, and income from Nevada Con. dividends $375,187.51, making a total of $1,535,362.53. Exclusive of the income from the Nevada Con., the direct income would be $1,160,175.02, thereby occasioning a direct deficit for the quarter of $26,452.48—no mention of which is made by the management. However, in order that the report might appear correct, the production cost of copper is stated at 10.175 cents per pound and the earnings are computed on a sales basis for the copper of 15.069 cents.

Considering the operations from a more logical point of view, and one more readily understood by the general public, it appears that (and the management's figures for the preceding quarter are used exclusively in the absence of the figures for the quarter in question, which will doubtless show an increase relatively to those for last year), on the gross copper porduction of 23,884,467 pounds of copper from the 1,460,707 tons of ore treated during the quarter in question; the basis of operating cost per ton being,—mining and milling 83.91 cents; freight from mines 28.48 cents; smelting, refining, and bullion freight 83.422 cents, and selling commission 2.88 cents, the total cost of treatment per ton of ore would be—exclusive of stripping expense or credits for gold or silver—$2,906,806.93, equivalent to $1.99 per ton. On the GROSS production of copper the cost per pound would, therefore, amount to 12.17 cents per pound. Then, assuming the sales price on copper to have been 15.07 cents per pound, the net profit on the GROSS production would be $692,649.55 for the quarter. Deducting this amount from the dividends paid, $1,186,627.50, a direct deficit of $493,977.95 will be apparent. However, allowing a credit of 0.957 cents per pound copper produced on account of credits for gold and silver there will be a reduction occasioned thereby amounting to $228,574.35, which, deducted from the original calculated deficit given above, would leave a net deficit of $265,403.60 for the quarter. Should we add to this the direct cost of stripping operations for the quarter (using the factor of 26.35 cents per ton as the minimum cost per ton of stripping 822,246 cu. yds. removed during the period mentioned), the direct deficit for the quarter would be $715,775.49—or approximately seven-elevenths the amount which the company claims to have earned as direct income from actual operation.

WALKER AND RAY CON.

George L. Walker, editor of the Boston Commercial—and who should be classed as "associate managing editor" of the Utah Copper, Ray and Chino companies—has been making an inspection, or claims to have been making an inspection of the Ray Consolidated. It is impossible to take seriously anything that Walker says about anything, so it is hard to believe, in this instance, that he has been within 1000 miles of Ray. If he has, his findings appear all the more ridiculous. As an illustration listen to this:

> I took pains to investigate the various criticisms of Ray's operating practice that have been made by alleged experts. One of these is that in reconcentrating the concentrates, which is done for the purpose of eliminating additional silica and thus reducing the cost of smelting, considerable copper is lost. As a matter of fact, every drop of water and all the tailings from this operation are carried back and passed again through the mill with the ore, so that no possible loss can result. This criticism is on a par with the others: it is made by men who have not informed themselves.

Granting, for the sake of argument—the kind of argument that Walker likes to palm off on the public—that the Ray Consolidated is running its mill at a capacity of 6500 tons per day, and granting that in the first operation 400 tons of concentrates are produced, we then have 6100 tons of tailings to be returned (according to Walker's statement) to the top of the mill and mixed with new ore. As the mill is able to handle only 6500 tons in twenty-four hours, it follows that after 400 tons of new ore have been

added to the returned tailings, the mill's full charge of 6500 tons has been provided. Continued from day to day it would require about fifteen days by this process to rid the plant of the first 6100 tons of returned tailings and after the first day's operation there never would be room for more than 400 tons of new ore charge. Maybe the plant now is being run that way; we don't pretend to know. If it is, it is certain that the regular grade of mill ore is not being supplied to fill up the total tonnage treated. They must be utilizing the best grade of ore obtainable from the Ray Central, otherwise the claimed amount of copper produced would not be forthcoming.

However, while it is generally believed that the practice at Ray is indefensibly bad, no one charges that it is as bad as Walker would make it out to be.

BUTTE AND SUPERIOR MAKES AWFUL SHOWING

A synopsis of the first annual report of the Butte & Superior Copper Company has been received by telegraph, and in it President MacKelvie is made to say that the amount of ore fully and partially developed is 1,200,000 tons averaging 21.7 per cent zinc; and further, that "the ore blocked out, together with that indicated, is sufficient to supply the milling facilities at full capacity for not less than six years."

During the past several months numerous reports have been circulated by the company's management that the two mill sections, when placed in operation, will have a normal capacity of 1,200 tons of ore daily and that a recovery of 90 per cent of the zinc mineral content of the ores treated will be effected. Under these conditions, and on a tonnage treatment basis of 36,000 tons monthly, the time required to exhaust the entire ore reserves in the mine will only be 2.8 years.

Therefore, assuming a mill extraction of 90 per cent of the zinc mineral, and the production of a concentrate averaging 47 per cent zinc, theoretically the ratio of ore concentration will be as 2.4 to 1, thereby affording a production of 500,000 tons of zinc concentrate. Of course, the theoretical perfection will never be attained, but the figure serves a very useful part in the calculation of the value of the property as now developed, and according to the management's own figures.

Thus on a basis of production of 500,000 tons of concentrate containing 47 per cent zinc, and a normal zinc market obtaining, the value per ton of the product as indicated by previous operations will be $23.60—equivalent to a gross value of $9.83 per ton of ore in place in the mine. Deducting from the gross value of the ore in place the cost of mining, milling, and miscellaneous expense, the net profit (under the most advantageous operating conditions) will amount to approximately $3.83 cents per ton. It will be apparent then that, incident to the treatment of the 1,200,000 tons stated, profit to the amount of $4,596,000 will be—or rather should be—earned during the entire life of the property. Amortizing the issue of $3,500,000 stock, the net return at the expiration of 2.8 years will be approximately $1,096,000—equivalent to about 32 per cent on the original capital. The value of the $10 par value stock then will approximate $13.20 per share, or less than half its present inflated quotation.

THE FATES AGAINST THEM

The slump in the shares of Butte & Superior company to about 26 has been one of the recent events of interest. The mine owned by this company is without doubt a good mine, which will eventually pay dividends, but according to the impartial and reliable accounts that come to us its exploitation has been sadly bungled. The bungling has been peculiarly unfortunate in that it has coincided with one of the periods of 7c. price for spelter, which occur only once in about ten years.—Engineering and Mining Journal, May 10.

The trouble with Butte and Superior's exploitation is not particularly different from the blundering, floundering campaigns that the same crowd of manipulators have conducted on several other propositions and in which results have proven just as disastrous to all concerned. Month after month during the high-priced days of spelter, the sponsors for Butte and Superior were constantly declaring they had the biggest zinc mine in the world. All other zinc fields in the world might become exhausted and still there would be limitless supplies available from this tremendous and easily worked deposit. Just as the great copper miners of the country had overlooked the record-shattering deposits of "porphyry copper," so had the lead and zinc miners failed to appreciate or grasp the opportunity that had been beckoning them for so many years from a point close to the portals of the great copper mines at Butte. The game was played to the limit and the promoters reaped a harvest. But the day of reckoning came. The users of spelter argued that if one-half of the tales concerning Butte and Superior were true that the time was close at hand when the price of the metal would break; so they waited for the drop. At the same time the truth began to leak out that the mine was nothing like it had been pictured and stockholders began to unload. The promoters tried to stem the tide that had set in and, with the aid of every friend they could muster and deceive into buying the shares on the decline, they began to clean up and "strengthen" the market. The result has been the absolute discrediting of the promoters and the financial wrecking of a large percentage of their close friends and market followers.

The spectacle is indeed a sorry one and disconsolate losers by the hundred are now bemoaning their fate and wondering at the barefaced perfidy of their erstwhile associates, friends and chums. Practically the same game, with like results, has been played in Utah Copper and the followers of Ray, Chino and Alaska Gold Mines are skating on even thinner ice than that which stood between them and disaster in the Butte and Superior fiasco.

We have seen these low-grade porphyry copper "magnates" expatiate on the tremendous worth of their mines and shares and we have heard them declare that, owing to the magnitude of their properties and the never-before-heard-of low figures at which they could produce copper metal, the owners of the deep mines of Butte and the Lake country would be put out of business; that it was going to be a case of "the survival of the fittest"—and that they were the "fittest." It is different now. A year or so ago they were going to swamp the world with copper; now they are "stalling" for time and hoping that something may happen that will yet save their precious necks. With the disintegration of these bands of marauders and their banishment to obscurity the legitimate miner will stand some show. Speed the day!

"Managing Director" Jackling seems to be just as busy as "managing editor" of the various companies from which he resigned (?) as he was when he held down general managerial jobs said to have paid him better than $100,000 a year. One would think that his successor as general manager would now be permitted to do some of the talking, particularly as John Hays Hammond, as managing director of Utah Copper, never "butted in" when Jackling occupied the driver's seat.

None of the eastern financial and brokerage publications seem to have discovered that D. C. Jackling, as general manager of the Utah Copper, Ray, Chino and Butte and Superior, has resigned. Is it because Mines and Methods "beat them to it?"

Problem Now Confronting Bingham Porphyry Operations

We present herewith a photographic reproduction of the workings of the Utah Copper Company's mines, as it appeared in the company's annual report for 1912, showing the "big pit" and a front view of all that portion of the hill on which steam shovels have been, and are now, being operated upon ore and capping. This view shows an exposure of the entire claimed productive area of the company's property on the west side of the canyon, including the ground of the original Boston Consolidated Company, and the more important group quietly obtained from Theodore Barnsdall some years ago and called the Payroll group.

Readers who have in their possession a similar photograph of this hill, published by Mines and Methods in June, 1910, will, by comparison herewith, perceive that practically all steam shovel operations upon ore and capping have been extended, and are now well beyond the Utah Copper Company's original west boundary, and within the territory embraced in the Boston and Barnsdall properties. It will also be seen that, as indicated by the depth to which the pit has been extended in ore, there remains above the bottom of the pit, and westerly from its westerly surface margin apparently a very large volume of ore within the original limits of the Utah possessions. But it is also apparent that any attempt to secure this ore at this time by extending the west wall of the big pit would at once, within a few feet, carry that wall up to a junction with the surface slope of the higher portion of the mountain, which has already been carved off to the highest degree of inclination at which the ground will stand. From which it is evident that, with the exception of what may be recovered from longitudinal extensions and greater depth of the big pit, all steam shovel ore for many years to come must be obtained by carrying the higher levels westerly into the Boston and Barnsdall ground.

In this connection it may be observed that all the earlier reports of the Utah Copper Company, which purported to show developed reserves of ores of the higher grade—as for instance, 60,000,000 tons of 2.0% ore, and some 92,000,000 tons of 1.6% ore—are located easterly from the westerly margin of the big pit, shown in the picture, and therefore not available for steam shovel mining, because the easterly margin of this pit already encroaches very closely upon the canyon stream and county wagon road; so that all such ores, if indeed they have any existence at all, must be recovered by some underground method of extraction. And, as it was never claimed by the original owners of the Boston that any portion of the thirty-five or forty million tons of ore said to be developed in that ground at the time of its absorption by the Utah company, was of a grade above 1.5% copper—which estimate has been found to be far too high—the constant depreciation of the copper tenor of the ore which has been experienced, as the works extended into the Boston and Barnsdall ground, and, as shown in the later reports of the Utah company, can readily be understood and appreciated. And then, when there is added to the volume of this lower grade mass at least 100,000,000 tons of almost barren capping, as has been previously shown in this journal—and conceded by the Utah Copper management—no one can be surprised that the entire mass of the ore being sent to the mills should show a copper tenor quivering upon the danger line, which can hardly be compensated by the assumed expansion of ore reserves.

Visitors, and especially engineers, who have witnessed the operations of the steam shovels in this great pit could not have failed to note the great disadvantage and excessive cost which attends the operation of the shovels employed in the extraction of the ores therefrom; and all have marvelled at this expensive operation being continued at all, in view of the enormous mountain of ore apparently available for cheap mining. Of course the operation of the shovels, as seen at the bottom of the pit, was in the highest degree spectacular and impressive, which went far to round out that feature of the general scheme. But the reason for such operations lies much deeper than any purpose to startle or impress the mind of the casual visitor.

INTERESTING EARLY HISTORY.

Before proceeding further in this regard, and in order that our readers may fully realize the problem with which the management is, and has been for several months past, confronted, it will be necessary to relate a bit of the earlier history which attended the inauguration of steam shovel mining upon the so-called Bingham porphyries. At the outset there was a very deep, though friendly, rivalry existing between Manager Jackling and Mr. Samuel Newhouse, manager of the Boston Consolidated, as to whom should lead the record in inaugurating the mining of these new-found ores on the stupendous scale which had been mapped out by each. Perhaps it was not the fault of these gentlemen that previous to that time neither had ever received any technical training in matters pertaining to the nature or formation of orebodies, nor any practical experience whatever in the actual mining or reduction of ores of any description, save, and except, on the part of Mr. Jackling who had considerable experience in the operation of roasting furnaces and had assisted in the manipulation of ores treated by the cyanide process at Mercur, this state. But whatever was lacking on the part of either in point of knowledge, and experience in the matters of this character, was made up in enthusiasm of each to outdo the other, and both to excel the world's record—at least in the magnitude of operations and spectacular effect.

Mr. Newhouse was first to instal and put in motion the steam shovels. Having in a remarkably brief space of time equipped the Boston hill with a full complement he proceeded to strip off the surface of what had previously, by underground exploration, been determined to be the richest portion of the Boston hill, and by the time the mill at Garfield—the erection of which began about the same time—had been completed in one of its sections, a large area of the surface capping had been stripped down so as to lay bare a vast tonnage of smiling ore. Then began the more serious task of shoveling up the precious substance and sending it to the mill.

The mill had been planned and constructed by a skillful mechanical engineer whose selection of machinery adapted to the treatment of the ore was standard in kind and the best of its class. There was no so-called teething or trying out of the machines that composed the equipment of this mill, each part being signally well adapted to the duty required; so that, from the moment of starting, results, in point of capacity, were all that had been expected. The yield of copper at once arose to about 70 per cent of the content of the ore, and was

Picture Taken from Last Annual Report of Utah Copper Co., Illustrating Problem Now Confronting the Management.

later raised to as high as 75 per cent, and the concentrates were clean in respect to silicious content. Everybody was happy. Mr. Newhouse, whose portrait had theretofore been published in the daily papers with almost tiresome frequency, appeared again in all the papers on the day of the starting of the mill—this time with his hat on, for he was busy all the time.

It may be observed that previous to the inauguration of these operations Mr. Newhouse had closed the sale of his interests in a neighboring mine called the Highland Boy, for which he received a very comfortable sum—a little more than $4,000,000—thus giving him a start several months in advance of Manager Jackling in notoriety which comes only from liberal tips frequently extended to the mining editors of the local papers. Whereas, up to this time, Manager Jackling had only received casual mention, the campaign which was to make of him the greatest engineer in the world being then only in its inception.

The accumulation of concentrates at the Boston mill soon enabled Mr. Newhouse to begin regular shipments to the Garfield smelter in compliance with a contract previously made, by which a basic charge of but $5 per ton was exacted for smelting. The contract also provided that the concentrates should contain 23 per cent, or 460 pounds, of copper per ton. The value of any deficiency in the copper contents of the concentrates so smelted was to be charged against the ore; that is to say, if the concentrate carried only 12 per cent copper instead of 23 per cent, as guaranteed, the shipper was to pay the smelter the value of the difference between 12 and 23 per cent. Now, Mr. Newhouse not having had previous experience in dealing with smelters in the sale and treatment of ores, it had not occurred to him that the inclusion of iron, or any foreign substance into the ore, could become a matter of any consequence, or that the presence of such foreign substance, being of the same specific gravity of the copper minerals, might interfere and render impossible the production of concentrates containing 23 per cent copper. He knew he had a lower smelting charge by two dollars than Jackilng, and that was enough for him to know. At all events, the concentrates looked clean.

But, upon the arrival of the first shipment of concentrates at the smelter, scientific determination of the contents thereof developed the fact that there was contained but little more than 8 per cent copper; but in some manner, 35 per cent and more of iron had become mixed with the product. Even this was a most desirable compound for the smelter and as such would have commanded a smelting charge not exceeding $2.50 per ton; but, under the contract which required 23 per cent copper, upon settlement the mine would be required to pay over to the smelter a sum probably very much in excess of the total value of the resulting concentrates.

Of course, operations under these conditions could not be continued and the work of extraction would at once have to cease. The mill, however, cleaned up so much of the ore as had already been delivered at the bins and piled up the concentrates at the mill for future consideration. All further operations of the shovels, which had cost, up to this time, over $850,000, were suspended and the mine force was thereupon placed underground and began the extraction of ore from enriched channels which contained, at the same time, a low percentage of iron, and in this manner the mill was thereafter supplied with such ore and operated very successfully up to the time of its absorption by the Utah Copper company.

Later extensive exploration of the great mass of mineralized rock of which the Boston hill is composed, outside of the fissures, showed persistent presence of iron in combination with copper to the extent of 4 per cent and more, which, as before indicated, would produce a concentrate containing 35% iron, and not more than 8 or 9 per cent copper, so that with this experience in view, the fact at once became apparent to Mr. Newhouse that, aside from the narrow channels before referred to, it would be impossible ever to operate the property profitably until the existing contracts expired, and as the contract was for a term of twenty years, Mr. Newhouse was not long in deciding to formulate some plan by which the property could be unloaded upon the Utah Copper company. And so it was done.

And now the management of the Utah Copper Company, having practically exhausted all other supplies of ore available for cheap extraction, finds it necessary to concentrate all operations upon the work of extraction and treatment of the same orebodies that had proved so disastrous to the first hopes of Mr. Newhouse, and paradoxical though it may appear, the Utah company enters upon the treatment of this particular ore under a smelting contract which requires, under penalty, a greater proportion of iron in the concentrates than results from treatment; that is to say, more than 35 per cent iron. And yet, at the same time, because of this excessive iron, the company is being mulcted by the same smelter contract to the extent of about two cents a pound on all copper produced.

A brief explanation of the Utah company's smelting contract will make clear the predicament into which the company has drifted, and which must sooner or later result in the wreck or suspension of work on this particular ore, or a modification of the contract so as to make it conform to conditions enjoyed by others who may send ore to the smelter without a contract at all. The contract of the Utah Copper Company originally provided first, for a flat charge of $6 per ton, but it also provided that the concentrates should contain ten per cent iron in excess of the total contents of silica; that is to say, if the concentrates contain thirty per cent silica they must also contain forty per cent iron, otherwise the company must pay ten cents per unit for each unit of iron found to be deficient of these proportions; no requirement is made, however, respecting the percentage of copper contained in the concentrates.

Now, it transpires that all that portion of the original Utah ground from which ores with which to supply the mills have heretofore been obtained, including the lower portion of the stope above the big pit, and all of the ground easterly of the canyon in which extensive underground operations have heretofore been conducted, and also the ores within and bordering along the big pit, were much higher in copper content than the ores of the Boston hill referred to, are very lean in iron, so that concentrates produced from this area, whilst containing an average of twenty-eight per cent copper and better, and some thirty-five per cent silica, contain a general average of less than ten per cent iron.

These facts had been determined by Wall and DeLamar by extensive practical working tests made upon ores taken from all parts of the property and concentrated in a small mill nearby equipped for the purpose. And although Mr. Jackling was in position, by reason of his employment at the DeLamar works at Mercur at the time, to have become familiar with the mineralogical characteristics of the ore and concentrates, he, like Mr. Newhouse, was not aware that the presence or absence of iron in an ore of this character, cut any figure at all; and hence he was concerned only in securing a low basic rate for smelting the copper out of the concentrates. But when returns began to come in of settlements for concentrates delivered at the smelter it was found that, while the copper contents averaged twenty-eight per cent and higher, the silica contained was thirty-six per cent and the iron only ten per cent, thus producing a deficit in the guaranteed iron content of the difference between ten per cent and thirty-

six per cent, to which must still be added ten per cent iron in order to make that element exceed the silica by the required amount. In other words, the iron content was short of contract requirements thirty-six per cent which, at ten cents per unit, gave the sum of $3.60 to be added to the smelting charge of $6, bringing the whole sum up to $9.60 per ton of concentrates. And, for some months thereafter, the product of the Copperton mill was settled for on this basis, the smelting charge varying from around $8.50 to $9.60, as before shown, the manager apparently not being aware of the existence of anything irregular or oppressive in the terms or operation of the contract.

But in course of time Manager Jackling became wise to the imposition as he then regarded it, and by the intervention of powerful outside interests, the smelting company was induced to modify the terms of the contract to the effect that the total charge for smelting ores should not exceed $7 per ton; and as it could never be less than $7, because of Jackling's iron deficiency guarantee, it has remained at that figure.

We now come to the little joker which is rapidly eating into the vitals of the Utah Copper Company's net profit surplus, which may be briefly illustrated as follows: The average copper contents of the concentrates produced from ores obtained on the original Utah side, as above indicated, has been about twenty-seven per cent, equally to 540 pounds of copper per ton of concentrates, for which the smelting charge is $7, being equal to about 1.3 cents per pound. Now, the ores of the Boston Con. hill, upon which Mr. Newhouse wrecked his little craft as before related, must, as we have seen, afford for years to come at least practically the entire supply required for the mills of the Utah company contains, treated alone, as we have seen, only about eight per cent copper and thirty-five per cent iron. By a judicious mixture, however, of Utah ores it appears that the company has been able to raise the copper content to about twelve per cent. A ton of such concentrates would contain 240 pounds of copper only, the charge for smelting which is $7, being equal to about 3 cents per pound copper, or about 1.7 cents per pound of copper in excess of the general cost of smelting the concentrates from the original Utah ores, which contained, as we have seen, about twenty-seven per cent copper and low iron. Thus it will be seen that the Utah company has had its cost of producing copper increased nearly one and three-quarters cents per pound, by reason of the presence of a proportion of iron which, under fair competition, and not bound by a contract, should have reduced the cost of production by at least two cents per pound.

To overcome this disadvantage by raising the copper contents of the concentrates, and relatively lowering the iron constituents, the Utah company has been compelled to inaugurate the spectacular and novel scheme of extending a spiral railroad into the earth as shown in the big pit, in order to secure the proper mixture without regard to cost. This pit has already reached a depth of 225 feet, and a length of something more than a thousand feet the widest place in the bottom of the pit being about 400 feet. It is therefore evident that but little more of the desired mixture can be hoped for from this source, and as the stopes on the east side of the canyon have long since been practically exhausted, it is certain that Manager Gemmel is up against the "real thing."

Verily, there are some things in the smelting business always on tap to tangle the feet of the unsophisticated "mining man."

The annual report and the first quarterly report of the Chino Copper Company for this year are out, but we find no mention in either of them of how much it cost to pay the dividend on the shares issued to Parisians. It was probably an oversight. We respectfully call the attention of the management, the Boston News Bureau and George L. Walker to the matter.

Scheme for Control of Noxious Smelter Fumes

By AL H. MARTIN.

The control of smelter gases presents a problem of pressing importance to many copper producers. The generation of sulphuric and sulphurous acid gases by reduction of sulphide ores has stirred anti-smoke agitation in Montana, California, Utah and other states, and in some districts has forced total cessation of activities. As a result, prosperous towns have been suddenly ruined, and active districts virtually depopulated. The principal warfare against the smelters has been carried on by the agricultural interests, but in some instances civic bodies and the Federal Government have proceeded against the operators.

Mammoth Smelter, Showing Bank of Cooling Flues and Baghouse.

The campaign against the smelters has naturally stimulated efforts on the part of the operators to perfect methods for the elimination of the deadly fumes, but the problem presents so many complications that measures of effective control are exceedingly difficult to develop. The baghouse system seems to be the most satisfactory practical method for the control of the sulphuric acid gases, but even this device has failed to render entire satisfaction in all cases. The sulphurous acid gas is even more

difficult of control than the first-named fume, and the methods at present in vogue for the reduction of its harmful agencies is by diluting it with many times its own volume of free air. This simply reduces the volume of gas escaping in a given time from the stack, and more widely scatters its harmful particles.

Most of the affected plants still operating are obliged by legal restrictions to reduce the sulphurous acid gas (SO_2) to less than 0.75% by volume as it passes into the atmosphere, while the sulphuric acid gas (SO_3), and all dust, must be completely eliminated. This ruling is based on the agreement between the Utah agricultural interests and the United States Smelting, Refining & Mining company, in the Midvale smelter case. But while several plants operate under this compact, the charges are constantly made by the farmers that the law is not fully complied with in many instances—an assertion stoutly combated by the smelting interests.

The baghouse has proven the most practical system yet devised for the control of the sulphuric acid gases, provided these fumes are sufficiently neutralized by zinc oxides, hydrated lime, or other agents. But the contrivance is of little use for the treatment of sulphurous acid gas, which is a most destructive element, and has caused most of the friction between the operators and their antagonists. Consequently several attempts have been made to perfect devices that would satisfactorily deprive all the gases of their harmful properties. Thus far no practical method has been commercially applied, although one or two processes are showing promise under experimental conditions. SO_3 is a particularly active agent, and readily uniting with atmospheric moisture forms sulphuric acid, an element violently destructive to vegetation, fabrics and most metals. SO_2 while less active than the sulphuric acid gas, is generated in greater quantities, travels to great distances, possesses many harmful properties, and is particularly difficult to govern. The great quantities of solid matter escaping from the stacks in the form of dust have also given rise to many complaints, as it often carries arsenic and other poisonous substances, inimical to health and vegetation. The baghouse has proven encouragingly efficient in arresting the dust, in addition to its control of the sulphuric acid fumes, and its employment has facilitated the operation of smelters that otherwise would be unable to remain in commission.

BAGHOUSE OPERATIONS.

The baghouse is usually composed of from 2,000 to 4,000 bags, especially woven of pure wool for the purpose. While their size varies in different plants, many operators have adopted dimensions of 34 feet long by 18 inches wide. The bags are separated into sections, with about 100 bags to a division. Suspended vertically from a series of racks, the bags extend into hoppers, in which the dust and fume are shaken by mechanical agitation. The shaking device is attached to an electric motor, and at intervals the passage of the gases into the baghouse is intercepted and the loaded bags shaken into the hopper located directly beneath each section. From the hopper the dust settles into a wooden trough containing water, from which it is drawn off into tanks and settled. The fumes coming from the blast furnaces and converters pass into the baghouse through a series of cooling pipes, to reduce the temperature of the gases, before coming in contact with the bags, otherwise the costly woolen bags, worth about $6 each, would be speedily consumed.

One of the most successful examples of the baghouse system is the plant of the Mammoth Copper comany, at Kennett, California, where the signal success of the device was the only means by which the company has been able to continue work in face of a determined opposition by the powerful farming interests. The fumes from the smelter are received at the base of the former stack by four pipes about 100 feet long and eight feet in diameter. These discharge into a flue 120 feet long by 15 feet square, through which the gases are drawn by two fans 11.5 feet in diameter and operating at 300 revolutions per minute. From this chamber the fumes pass into 45 cooling pipes four feet in diameter. Sprays of water cool the pipes. The pipes discharge into a cooling chamber where the temperature of the gas is further reduced by blowing in cold air through the top of the flue which is 15 feet square and 220 feet long.

The gas travels through the 900 feet of cooling pipes at the rate of 2,700 feet per minute, and on its arrival at the bags its temperature has been reduced from 280 to 93 degrees C. The 2,960 bags are set 21 inches apart, center to center, and suspended vertically from the shaking racks. The gas enters the bags through their lower ends, under pressure of the blast from the fans, and after passing through escapes into the atmosphere by way of five square towers. This arrangement more widely scatters the volume of the escaping fume than would be the case if permitted to issue from a single outlet. The baghouse is open as much as possible to admit large quantities of free air to cut down the volume of SO_2 which is claimed to vary from 0.4 to 0.6% in volume. The company possesses a distinct advantage in its treatment of the SO_3 in the way that the ores carry a large amount of zinc sulphide which becomes zinc oxide in the blast furnace and unites with the sulphuric acid gas to form zinc sulphate.

To make absolutely certain that none of this gas escapes, about 30 pounds of hydrated lime are tossed into the fan blast every hour to neutralize any SO_3 escaping the action of the zinc. Approximately 333,000 cubic feet of gas passes the fans every 24 hours. The daily amount of free air consumed ranges from 20,000 to 25,000 cubic feet on cold winter days, to as much as 125,000 cubic feet in the summer season, as the volume of gas is reduced by cooling. It is claimed by the Mammoth people that the escaping smoke contains no sulphuric acid gas or dust, and that the volume of sulphurous acid gas ranges from 0.4 to 0.6%. Thus the escaping sulphur dioxide is asserted to be rendered harmless. It is interesting to note that in about two years of operation, the dust has yielded sufficient gold, silver, lead and zinc to more than cover total cost of the baghouse, but the management has been thus far unable to discover or develop a method whereby these metals can be profitably recovered from the material.

The baghouse at the Kennett smelter is illustrative of the system generally, and indicates the good uses to which it may be put, but it has nevertheless failed to control the objectionable sulphur dioxide, that invisible gas that has occasioned such trouble on the Shasta copper belt and in other fields. Consequently many investors are endeavoring to perfect a process that will completely subjugate this harmful element, and several promising methods are in course of development. An attempt to destroy the sulphuric acid and sulphurous acid fumes by an electrical current was made by the Balaklala Copper company about three years ago at a cost of approximately $160,000. The method, known as the Cottrell process, was given an extended trial and under experimental conditions promised much. But when applied on a commercial scale it proved impractical for the purpose intended. The process at times registered a maximum efficiency in excess of 96%, but at other instances fell far below this.

As a result the farmers proceeded to take active measures against the company, and after numerous experiments and endeavors to increase the efficiency of the process, the Balaklala directors closed down the big mines and plant, and have since made no effort to resume work. The proximity of this

smelter to the Kennett plant undoubtedly developed unsatisfactory conditions for both, as the volume of harmful gases in a limited atmospheric area was augmented considerably over what it would have been under other circumstances.

YOUNG'S THIOGEN PROCESS.

A method for the control of all elements of smelter fume that has attracted considerable interest is the Thiogen process, invented by Dr. S. W. Young, professor of physical chemistry at Leland Stanford university. The method is based on the well known laboratory experiments that when sulphurous fumes are united with oil-gas and passed over heated coke or limestone, containing iron salts, the structure of the sulphur dioxide is disintegrated and the sulphur precipitated. Several experiments with the process have been made at the Campo Seco smelter of the Penn. Chemical Company, at Campo Seco, Cal., but it is evident that many points remain to be decided before the method can be commercially applied. Experiments are still being made, and several highly encouraging tests have been conducted.

The fumes from the blast furnaces are driven into a combustion chamber where oil admitted from a spray has been vaporized by a temperature of about 800 deg. Centigrade by steam-injected burners. The volatilized crude oil releases carbon, an element necessary for the destruction of the gases. The combustion chamber is composed of brick checkerwork and the gases are thoroughly united with the carbon before passing to the reaction compartment. This is also formed of brick checkerwork, with the apertures nearly filled with a mixture of equal parts of sawdust and plaster-of-paris moistened with water and containing small quantities of iron salts. In tne small spaces still remaining, lumps of calcium sulphide are placed. This forms a catalytic agent, naturally hastening the action of the carbon on the fumes. From this chamber the liberated sulphur passes in the form of vapor into the condensing chamber where it is cooled with jets of water and converted into the yellow product of commerce.

Calcium sulphide was selected as a catalyte because of its cheapness and general desirability as compared with a number of other substances that were given trial. It has been found desirable to thoroughly clean and concentrate the fumes before their admission to the combustion chamber, and under practical conditions an apparatus for this purpose is considered necessary.

Arsenic, selenium and other minerals are frequently associated with the sulphur in the composition of the fumes, and the presence of such substances in the precipitated sulphur would naturally unfit it for commercial usages. The best means of separation is during the period in which the minerals are in a volatilized state. For this purpose the vaporized fumes are passed through a broad, long, low, slightly-inclined condensing chamber, served with water sprays. The temperature of the gases is reduced sufficiently to precipitate the arsenic and other substances in the receptacles provided, while the more volatile sulphur passes on to the final condensing compartments. By the process, the structure of the SO_2 and SO_3 is said to be thoroughly disintegrated, and the smoke finally escaping is asserted to be practically free of all harmful properties. The gas is first passed through flues, to settle the dust, before being admitted to the combustion chamber, thus securing a clean product for treatment.

Numerous tests have been made with the process, and the greatest trouble appears to be the construction of a furnace wall that will resist the intense internal pressure. The furnaces at the Campo Seco smelter are of old design, and the leakage of walls has seriously handicapped experiments. Operating costs are also reported somewhat high, but the inventor believes that this expense can be materially lowered. It is pointed out that the recovery of the sulphur and other minerals in commercial form will largely compensate for fairly high operating costs, and the process is builded on the idea of turning the contents of the smelter fume to commercial account, in addition to depriving the gases of their objectionable properties. Further tests are being arranged for, and the fairly satisfactory results already obtained naturally commands respect for the method.

Prior to the conception of this process, metallurgists devoted scant attention to recovery of the valuable elements of the fume, and concentrated efforts on the development of a method for the control only of the sulphuric and sulphurous acid gases, content to accomplish this important point with slight consideration of the valuable sulphur and other substances going to waste.

THE NEW HESLEWOOD PROCESS.

Another process that is attracting considerable attention at this time, though still in an experimental stage, is the Heslewood process. This is a departure from the usual attempts to govern the fumes, and has given much promise at the few trials made. The process is based on an old principle, yet possesses many original features that makes it of particular interest to the mining world. The fumes are associated in the furnace with a small quantity of hydrogen gas, designed to break down the structure of the SO_2 with carbon subsequently employed to destroy the SO_3. The treated gases are then drawn by suction through condensing chambers into a reservoir of water, where the sulphur is precipitated and subsequently collected.

The small plant at which most of the tests have been made was erected at Heroult, Cal., by the Noble Electric Steel company. The furnace is an old one of the cupola type, formerly used by the Noble Electric company in smelting iron ores by electricity. With a diameter of five feet, it has an approximate capacity of 200 tons per 24 hours. The arrangement and operation of the furnace differs radically from ordinary practice. Instead of operating by forced draft, the furnace is worked by means of hydraulic suction, (this form of draft was employed by the ancients to some extent), and is said to have the advantage of reducing the volume of fumes, rendering their control correspondingly easier. The fumes pass from the furnace into a bustle-pipe, running around the furnace, which leads into a down-taking flue, terminating in an air-tight chamber. Into this chamber a centrifugal pump drives a jet of water under a 40.7 pounds pressure, which develops a powerful vacuum. This draws the heated fumes from the flue and the united force of the suction and stream of water carries the gases on through a condensing and agitating chamber, from which the sulphur and other minerals pass into the settling reservoirs.

In the experiments thus far conducted, ore carrying an exceptionally high percentage of sulphur has been smelted. The product was specially secured from the Iron Mountain mine of the Mountain Copper company, and averaged about 50 per cent sulphur. Such ore naturally generates an enormous volume of sulphuric and sulphurous acid gases, and the successful control of such an ore would make certain the control of a product containing a lesser amount of the objectionable mineral.

California crude oil was employed in place of coke for firing. Four burners were used and the petroleum introduced in the form of a spray. The oil generated an intense heat enabling the tapping of the furnace an hour after firing. As the smelting of the ore commenced, hydrogen gas was introduced to dissociate the oxygen from the sulphur, and facilitate the release of the latter from the other gases. From the furnace the fumes pass into the bustle-pipe and thence into the flue, where they are drawn through the carbon chamber. The vaporized carbon is obtained from red-hot coke, and by its use the structure of the SO_2 is further disintegrated and the SO_3 brought under control.

From this compartment the fumes continue to the condensing chamber and thence into an agitating compartment. The stream of water accompanying the gases from the condensing chamber enters the agitator under a pressure of 60 pounds per square inch and keeps the fume in violent circulation. The sweep of the water breaks up the bubbles of gas that would otherwise float on the surface of the tank, thus preventing any noticeable escape of fumes from this plant. From the agitating chamber the solution is carried into the settling pond. This is divided into compartments. The sulphur and other metallic substances settle to the bottom of one compartment, and when this receptacle is in use for a determined period, the solution is directed into a second compartment. By this means the sulphur can be cleaned up from the first compartment, and it is again ready for use. The smoke is then permitted to freely escape into the atmosphere from the surface of the water.

To guard against any escape of fumes from the agitating chamber, it is intended to place an air-tight hood over the compartment, and guide the elusive smoke into a small baghouse. This system has proven its value in recovering solids from the fumes, and with its union to the main plant, it is asserted every portion of the fume will be thoroughly treated, and all values extracted. An extensive system of dust chambers is also projected for a plant operating under practical conditions, as it is desired to have a comparatively clean fume before admitting it to the carbon chamber and following compartments. The use of hydrogen gas and volatilized carbon is stated to thoroughly break up the structure of the gases and render their effective control a matter of comparative ease.

The inventor states that the hydrogen is generated at small cost, and that its employment will not make the process a costly one, while it is probable that the carbon will be later generated from crude oil, as in the Thiogen process, instead of from coke, because of the lower cost. Tests have shown that the water used in the chambers and settling reservoir can be used over many times, provided the dust is largely extracted before the gases are admitted. Unless this is done the settlement of large quantities of dust in the settling ponds and chambers not only causes much annoyance, but also prevents the achievements of best results.

The employment of a suction draft in preference to usual smelting methods was adopted because of the less amount of oxygen consumed, and a corresponding reduction in the volume of the fumes. The inventor asserts that this method not only cuts down the volume of fumes four-fifths, but also increases the capacity of the furnace one-third. Such results with a single furnace, if borne out in actual practice, indicates the advantages accruing when several such units are operated in unison. It is further claimed that the powerful vacuum in conjunction with the intense heat resulting from the burning of crude oil, speedily clears the furnace of obstructions and prevents "freezing" even when zinc and other complex ores are being reduced. This claim is based on several tests with ores carrying a high zinc per cent.

In addition to the sulphurous and zinc ores, several tests have been made on iron-bearing ores from the mines of the Noble Electric company, with satisfactory results. It is essential that the furnaces be hermetically sealed when admitting the hydrogen into the charge, and that water jackets be provided for furnace and bustle-pipe. In the earlier experiments the intense heat from the furnace fired nearby woodwork, and seriously interferred with operations. Porous furnace walls have caused much annoyance; not only permitting the escape of heat, but also admitting large quantities of oxygen.

INVENTORS ARE HANDICAPPED

The inventor, J. A. Heslewood, has been experimenting with methods for the control of smelter fumes over a period of several years. The anti-smelter agitation has been particularly violent in California, and most of the smelters have been forced to close, or provide costly baghouses. Consequently the problem has attracted particular attention in this State. Before testing out his ideas at Heroult, Heslewood made numerous experiments with a minature plant at Oakland and Redding, and early became convinced that one of the chief points to be mastered was the reduction of the fumes to as small a volume as possible. With this end in view he adopted the hydraulic vacuum in preference to the ordinary forced draft. Early attempts to destroy the sulphur dioxide by bringing the fume in intimate contact with vaporized carbon and discharging the solution into water proved unsatisfactory in many ways, but the use of hydrogen indicated the advantage to be derived from employment of this gas. It was later found necessary to subject the solution from the condensing chamber to violent agitation, otherwise the gas bubbles floating on the surface of the water permitted important quantities of poisonous fumes to escape. The inventor has been constantly handicapped by lack of satisfactory apparatus, and has thus been forced to work under pronounced disadvantages.

So determined has the opposition of the California farmers been against the smelters, that permission to experiment with new methods has been denied, the grangers demanding that the companies conduct the tests in some sterile region remote from their plants. This has not only handicapped the copper companies in trying out new methods, but has also worked a decided hardship against inventors, as Heslewood, Young and others have learned.

While the Heslewood process was primarily designed to control the sulphur dioxide gases and facilitate the recovery of sulphur and other minerals from the fumes, it has been developed with a view to economical operation. It was early realized that the cost of treating the smoke and recovering metallic contents must be kept down, otherwise no company would feel justified in employing it, no matter how successful its mission might prove. The inventor claims that the erection of a plant along his designs will not exceed, and may not equal, the cost of an ordinary installation of like capacity, while the operating expense will be lower. Heslewood freely admits that there are several minor problems yet to be overcome, but insists that these are largely of a mechanical character, susceptible of certain satisfactory solution. The experiments made have been followed with much interest by operators on the Shasta copper belt, and it is certain that a thorough demonstration of the merit of the method under practical conditions will lead to its adoption by most of the companies now lying idle because of anti-smelter fume regulations.

There are several other methods undergoing tests in California, Montana and other States and some, apparently, present many points of interest. But it is the sad truth that many methods that work admirably under experimental circumstances, fail lamentably when applied to practical conditions. It has been suggested that the SO_2 be liquefied by ice or refrigerating machines, but the crucial objection is the absence of a market for the product, as the demand must be broad to take care of the enormous output that would attend such work.

The suggestion that the product could be used as a refrigerant has been met by the contention that the market is not only undeveloped, but also problematical, and that an immense expenditure of capital would be required for the development of a possible market, in addition to the heavy costs attending the installation of requisite machinery. Others have recommended the union of the objectionable fumes with slag, with subsequent treatment for recovery of metals, potash, green vitriol and other products from the compound.

THE ART OF MINING THE PUBLIC

Dishonesty of Men Responsible for Major Portion of Mining Losses—How the Guggenheims Thrive on the Use of Other People's Money

By SIDNEY NORMAN.

In the present demand for legislation tending to protect the innocent, if unwise and over-greedy, investor, an agitation that has already resulted in "Blue-sky" laws as variegated in operation as was Joseph's coat in color, the mining promoter has invariably been held up to the public as a shark without conscience, insatiable and altogether destitute of honest intention. The big operator, he who deals in millions filched from the pockets of the innocent, has been generally overlooked.

Though, unfortunately, there have been many sad experiences in the history of latter day mining, actual figures would doubtless show that the petty promoter has received but an infinitesimal tithe of the sums wrested from the savings stocking by the dishonest efforts of the real estate shark, the stock exchange specialist, the irrigationist or the industrial fakir. Mining has one advantage at least and that in the fact that there is always hope, deep-hidden though it may be. No man can see farther into the earth than his neighbor and so the mining optimist cannot be proven a complete liar until handpower and drills have chipped their way to the points where his optimism lies walled up, in granite, or quartzite, or what-not.

EAST VS. WEST.

While a few have come out of the west with new brands of goods to cause sorrow to the innocent purchaser of mining shares, it is nevertheless a fact that the eastern promoter has been able, from time immemorial down to this day to give his western brother cards and spades in mining promotion rascality that tickles the dollar and the nickel from the widow, the orphan, the easy mark and the fool. This does not mean to insinuate that the eastern promoter is more dishonest than his confrere from the hither side of the Rockies, but it does mean that every trick of the trade is known within gunshot of Wall Street and that if the pilgrim wishes to "put over" a new one he is compelled to arise earlier than is fashionable in Gotham. The western man is an apt pupil sometimes, however, and when he has seen the shearing operation performed in artistic New York fashion he usually sends for his household goods and settles down to imitation that is something akin to sincere flattery and sometimes more cajoling than the original article.

Mining the public has its risks, of course especially in these days of investigations, but, so far as immediate results are concerned, it possesses allurements not apparent to the casual observer of real pick-and-shovel operations. Usually, real mining propositions, backed by the word of men of truth, directed by others who place honesty above the pleasures of get-rich-quick schemes have resulted in dividends and general satisfaction. The pity of it is that all losses are debited by the uninitiated to the mining industry and, as a consequence, the honest mining man finds it more and more difficult to secure capital for meritorious propositions as time goes on. Credit for success usually goes where the press agents of those identified with it direct. The mining industry itself rarely receives its due in public estimation.

"HIGHER UPS" RESPONSIBLE.

Those who are financially highest in the mining promotion firmament and who might, therefore, in all reason, be expected to do their utmost to provide protection for the investing public, have been primarily responsible for the contumely that is heaped upon the mining industry and that condition applies to New York as to no other place. In one case depreciation of no less than $20,000,000 in a few short years has resulted from the manipulations of one of the strongest corporations in the world, one that now has the effrontery to suggest public subscriptions to another $110,000,000 concern, this time in Chili, and of which it intends to retain nineteen parts and hand to the public three parts in return for all the money necessary to develop the ground.

The following history of the looting of Federal Mining & Smelting Company is a typical case and one that will tend to prove the contention that mining losses are more often occasioned by the rapacity of men than by the failure of the mines themselves. The details of the plan devised to deprive the public of its just due will show that the loss cannot be laid to the mining industry. The mines produce as they did when securities represented twenty million more good American dollars than they do today, but profits have been, and still are, diverted through a secret syphon that carries them into the private pockets of those who occupy before the law the positions of trustees of the peoples' savings. It is to prevent just such dishonesty that additional criminal statutes are needed; in comparison to operations of some of New York's gilded brigands the speculations of the small promoter fall into insignificance.

THE COEUR d'ALENE DISTRICT.

The Coeur d'Alene district of Idaho is generally known as the most prolific lead-silver producer on the American continent and its contribution to the world's supply of lead has steadily risen since its discovery in the 80's. At the present time it produces practically one-half of the desilverized lead of the United States and close to 30 per cent of the domestic supply from all sources. In the earlier stages of its development dividends went into the pockets of local men, but gradually the extent of its earning power broke in upon the intellect of Wall Street and at this time a great number of its producing mines are owned by eastern stockholders.

Among those who early showed faith in the district was Frank Rockwood Moore, for many years one of the leading citizens of Spokane, Wash., who occupied the position of president of the First National Bank. He it was who developed the Emma and Last Chance properties at Wardner, and many thousands of dollars were supplied by him for that purpose. Then evil times fell upon the city and entire country and, following the great panic of 1893 the First National Bank was forced to close its doors, with a large portion of its assets tied up in the bonds of the Last Chance Mining Company. At that time the company was managed by Charles Sweeny, who commenced a romantic career at Virginia City, Nevada, and who in the past decade became a figure of prominence in the mining promotion world of New York.

CONCEIVED AND BORN IN DISHONESTY.

It would be idle to follow the course of events which, following the death of Mr. Moore, led up to the acquisition by Sweeny of the mining securities held by the bank but it is sufficient for these purposes to say that charges of dishonesty against the receiver of the bank became the subject of an inquiry by the Department of Justice in 1906.

Strangely enough, William Loeb, Jr., then secretary to President Roosevelt, now glorified "press agent" of the Guggenheims, is the man who notified the depositors of the First National Bank of the action of the Department of Justice, following an urgent demand of the President for a complete report. This merely shows the irony of a fate which now demands that Mr. Loeb confidential adviser of presidents, shall act as mixer of white-wash for some whose rascality he was partially advised of when he occupied an honorable position a few years ago.

Less than nine years after the failure of the First National Bank the interests in its possession had been gathered under the ownership of the Empire State-Idaho Mining Company, dividends had been paid, and Sweeny had moved upon New York for the purpose of merging that company into a larger concern, which subsequently assumed concrete shape as the Federal Mining & Smelting Company, listed on the New York Exchange in 1903, and now used as a football in its sacred precincts.

ROCKEFELLER AS PARTNER.

In those days Sweeny did not possess the breezy entree to New York banking houses later secured through his eminent qualifications but he was resourceful and forceful and early grasped the knowledge that the public purse would be opened wider to him could be but interest some financier of commanding position and use his name as a red herring across the scent of speculation. There was nothing small about him, nothing he would not dare to accomplish his ends, and so he decided upon John D. Rockefeller as his future partner, and to that end set his plans.

Prior to that time the Rockefeller interests had purchased the Monte Cristo mines near Everett, Washington, and, to provide reduction works for ore that never seemed to be forthcoming had built the Everett smelter at tidewater. Several years were consumed in proving the property worthless and it is said that the sum expended approximated $800,000. For some time prior to Sweeny's advent upon the scene the mines had remained idle and the investment appeared to be more or less a total loss.

A REVEREND PROMOTER.

Sweeny laid his plans for the formation of Federal before Mr. Rockefeller's representative, in this case the Rev. Frederick T. Gates, and hinted that the proposition, rightly handled, provided a method by which the losses in the Monte Cristo mines could be shifted to the public. Whether or not the Standard Oil interests experienced any twinges of conscience is not set forth in the records available, but at least it is certain that the Monte Cristo mines and Everett smelter became a part of the assets of the Federal and the public was duly apprised of the fact that the greatest financial power in the world had considered the company's wares good enough to warrant a very large investment.

At the same time George J. Gould was duly "touted" as another of the big ones who could not resist the temptation to take on a little Federal stock but so far as known no mention was made of the fact that before his subscription was made it had been arranged that all shipments of ore from the company's mines should be routed to Colorado points over the Gould system of railroads at satisfactory rates.

To make the anaesthetic quite complete John D. Rockefeller, Jr., Rev. Frederick T. Gates, George J. Gould, E. Parmalee Prentice, son-in-law of Mr. Rockefeller, and George W. Young the well-known Wall Street banker, were elected directors.

GUGGENHEIMS PANIC-STRICKEN.

The arrangements carried promise of serious portent to the hearts of the Guggenheim Brothers, however, then about completing plans for monopoly of the lead industry with the public's funds, and, so the story goes, long and earnest consultations resulted. At no time did the Federal seriously contemplate entering the smelting field but the old Everett smelter served the purpose for which it was intended and scared the Guggenheims into frenzied belief that the most powerful financial interests of the country were ready to jump on their backs and wrest control of the industry from them.

So overtures for peaceful settlement were made, with the eventual result that the Guggenheims secured a six-year contract for all Federal ores, at an attractive price and in part consideration therefor the sum of $600,000 was paid for the smelter and mines formerly owned by the Rockefeller interests, absolutely worthless as going concerns, but which had now served their purpose in catching the dollars and nickels of the innocent public. Federal, in its turn agreed not to enter the smelting business and everything was again lovely—except for the Guggenheims, who had been "stung" for $600,000 and very naturally were already plotting to recoup themselves from the depths of the public purse. It will not surprise the reader to learn that they did—most completely and thoroughly.

TRICKS OF THE TRADE.

Smelting and refining charges are more or less unintelligible to the general public, but it is necessary that the terms of the contract entered into in 1903 should be digested in order that subsequent events may be understood. Prices for lead are made in New York and St. Louis and are based upon lots of 50 tons for thirty day delivery. Incidentally, as the Guggenheims control the major portion of the lead output of the country, the price is made by them, as no dealer wants to sell for less than the trust quotation and it is obvious that he cannot sell for more.

It is claimed by the smelters that reduction of lead ore results in the loss of ten per cent of the values passed through the furnaces and, in consequence, while the loss is more theoretical than practical, all contracts are made for but ninety per cent of the lead contained in the ore. In other words, if a producer ships a ton of ore containing fifty per cent lead, it is evident that the shipment contains 1,000 pounds of pig lead. But he does not receive payment for that amount. Ten per cent is deducted for "smelting loss," and he receives payment, upon whatever financial basis has been arranged, for 900 pounds instead of 1,000. It is generally admitted that the practical loss in smelting is well covered by five per cent, so that on every ton of such ore the smelters "knock down" approximately fifty pounds of lead worth an average of about $2.10 in the past thirty years. Unimportant in small consignments, it can be readily understood how vitally this deduction influences the receipts of the smelting companies when applied to shipments that run into the hundreds of thousands of tons each year.

COURSE OF LEAD MARKET.

The average price of lead for twenty years prior to 1903, when the Federal-Guggenheim contract was made, had been around $4.00 per hundred pounds, while for the year 1902 the average had been $4.15. The contract, at that time reasonably fair to both sides, provided for settlement on a basis of ninety per cent of the lead in the ore, at ninety per cent of the price of lead in New York, so long as that price stood at $4.10 or less per hundred pounds. If the quotation advanced above that figure the producer and the smelting company were to divide equally the difference between $4.10 from the New York market quotation. Thus, if lead advanced to $4.50 say, the Federal

company received ninety per cent of \$4.10 or \$3.69, plus one-half of 40c, or a total of \$3.89 for lead selling at \$4.50 on the New York market. The smelting company took 61 cents per hundred pounds, in addition, of course, to the usual treatment charge, in this case \$8 per ton.

Under this basis of settlement heavy shipments were made by the Federal and quotations began to show activity on the New York Stock Exchange. When the company was organized, with \$10,000,000 seven per cent preferred cumulative stock and \$5,000,000 common stock, part of the latter had been given away as a bonus with preferred. The common stock, however, carried all voting power, the preferred stockholders being allowed no voice in the management of the property or in fact on any question but the increase or decrease of the volume of their own security. After providing the common stock bonus the insiders retained direction of the company's affairs without having subscribed a dollar towards its financial equipment.

REV. GATES "PUTS ONE OVER."

In the early part of 1905 there was a decided uplift in the quotation of common stock, an advance that could hardly be attributed to improvement in the conditions at the mines. Rumor says that the Guggenheims had been jockeying for control, and that, forgetful of the strength and experience of other interests connected with the company, had "shorted" a large amount of the common stock in order to depress the market and make a larger amount available at lower figures. The game appeared to be working well until suddenly there was a decided shortage of certificates for delivery

It then dawned upon the Guggenheims that the Rockefeller interests, through the Very Reverend Frederick T. Gates had been quietly absorbing additional holdings and had generously loaned large numbers of certificates to facilitate deliveries. The long and the short of it was that the Guggenheims were ordered to step up and settle and, after pardonable squirming, they did. For common stock given away as a bonus about two years previously they were compelled to pay a fancy price(rumor says \$120) and it is also said that nearly 20,000 shares changed hands. This represented some of the profit secured by the Rockefeller interests for a worthless smelter and more worthless mines that had been used as bait for the public and already sold once before to the Guggenheims for \$600,000.

Rumor also says that the persuasive eloquence of the Reverend Mr. Gates included a threat that, unless his terms were accepted forthwith, the Standard Oil-Amalgamated Copper interests would immediately enter the lead-smelting field. It is also said that an agreement was entered eventually into by which the latter undertook not to enter that field for a period of five years. Color is lent to this report by the fact that just five years later the Standard-Amalgamated began preparations to reduce lead ores and a little over two years ago became an active competitor in the Coeur d'Alene and other fields through the International Smelting & Refining Company, which "blew in" its lead stack at Tooele, Utah, last year after piling up nearly \$4,000,000 worth of lead-silver ores. This is high finance with a vengeance but as it affected only interests financially powerful, the harm was not general.

ROCKEFELLER LOANS TWO MILLION DOLLARS.

The Guggenheims, however, now possessed about 28,000 shares of the 50 000 issued common stock of Federal, besides having been mulcted in the sum of \$600-000 for the Everett smelter and Monte Cristo mines, for which they had no more use than a burglar has for daylight. Being short of funds when they accepted the generous terms of the Reverend Gates, they were compelled to borrow \$2,000,000 from John D. Rockefeller himself, and had agreed to pay him back, with an entirely satisfactory rate of interest, in \$500,000 payments. Annual notes of \$1,000,000 had also been given to Federal in payment for the smelter and Monte Cristo mines, so that these particular days do not appear to have been good ones from the Guggenheim viewpoint and scouts were already abroad in the financial land to devise some method by which the strain could be relieved.

When these emissaries reported to their superiors in due time it was decided, in the first place, that the contract for the ores of Federal, now vital to the supremacy of the Guggenheims in the lead smelting industry, should be perpetuated for a long term of years to offset danger of Standard-Amalgamated competition. Accordingly in October, 1905, the "dummy" directors placed in control of the company's affairs by the Guggenheims, met in solemn conclave and "whereas it was the desire of Federal to sell and the desire of the Guggenheims to buy," a new contract, to take effect four years later and run for twenty-one years thereafter, was entered into and the output of Federal thus bottled up for a period of years that would in all human probability run beyond the productive life of the mines. It should be remembered that this was in 1905, that the original contract of 1903 still had four years to run and that the Guggenheims were really both contracting parties. At this time Federal was producing approximately twenty per cent of all the lead of the United States.

AN UNHOLY CONTRACT.

By the time the Guggenheims had secured control of Federal the price of lead had advanced materially on the New York market, the average for the two past years having been around \$4.30 and the quotation on the day the second contract was signed in October, 1905, standing at \$4.85. In spite of this advance and in spite of the fact that a shortage in the domestic lead supply seemed not improbable within comparatively few years, the second contract called for lead settlement at the same level as provided by the contract of 1903.

This meant a loss of eighty cents for every hundred pounds of lead in Federal ores, or approximately \$6.17 upon every ton of crude ore or concentrates shipped to the smelters. Upon average yearly shipments running well over 100,000 tons it will be understood that the amount involved in one year was very considerable and in the twenty-one years covered by the contract simply stupendous.

Of course the contract also called for a treatment charge of \$8 per ton and provided for a freight rate of \$7.50 to Denver or Pueblo, the longest possible haul. The Guggenheim interests, however, maintain a lead smelter at East Helena, Mont., to which point ore can be transported at \$2.75 per ton. What becomes of the difference between the long and short haul rates on carload lots diverted to Helena can be readily guessed.

If Federal shipments should be maintained at present levels for twenty-one years from 1909, and if the product should be sent to Helena instead of Denver or Pueblo, the Guggenheims will have received approximately \$22,000,000 in excess of the \$8 treatment charge provided in the contract, which would in itself reach the respectable total of almost \$20,-000,000.

Two or three possibilities might prevent the collection of this tremendous unjust tax upon mines developed by public funds. The mines might be exhausted before the contract expires; the price of lead might depreciate to such a figure that mining operations would be unprofitable, or the efforts of minority interests to annul the contract and recover the amount taken above a fair charge since 1909, will prevail in the courts. Otherwise an act of God will be necessary to break the Guggenheim strangle-hold. It is useless to appeal to their sense of justice and square dealing. That has been unsuccessfully tried.

A LITTLE EASY MONEY.

Having locked up from marauding hands and having provided for the return many times over of their outlay, the Guggenheims lightly turned their attention to making some quick, easy money by stock manipulation. The first step was to issue 20,000 additional shares of preferred and 10,000 shares of common, ostensibly to provide funds for the purchase of the Morning and You Like mines at Mullan, Idaho, from the late Peter Larsen and Thomas L. Greenough. It is said that the price paid for these properties was $3,000,000, but they passed through many hands before finally reaching Federal and it is perhaps safe to assume that some of the money stuck to somebody's fingers on the way.

This new issue was offered to stockholders already of record, but meanwhile "bear" stories were circulated about the company's mines and the demand was by no means brisk. A little inside syndicate took up the balance remaining after the demands of stockholders had been satisfied, thus providing the Guggenheims with enough stock, outside of sufficient to retain control, with which to make a little manipulation very attractive from a monetary standpoint.

Production was maintained at high pressure and, with advances in lead and silver to help the game along, quotations on preferred were hoisted to $112½ and on common to $199 in 1906, when dividends of 17% on common were distributed, besides full 7% upon preferred. In 1907 common dividends of 14½% were distributed, but the manipulative campaign was then about over and no dividend on common has since been paid, except one of 1½% early in 1909.

One of the remarkable features of the campaign is the fact that men of great prominence in the financial world, men who should have known better, were drawn into the net and to this day retain common stock holdings that have cost from $145 to $199 a share. Women, too, appear to have been victimized even more than usual. Last year's list of stockholders shows that there are no less than 980 women holding stock of both issues all the way up to the high point.

CONCEALING FACTS.

Meanwhile evidence of control of Federal by the Guggenheims had been zealously guarded from the general public, though the stock books show that at no time since July, 1905, have they owned less than a safe control of common stock in the name of the American Smelters Securities Company. When the latter was listed on the New York Stock Exchange in 1909 no official mention was made of the ownership and none has been made since.

In 1911 the financial press of New York hinted at the real ownership of control and in December of that year "M. Guggenheim's Sons" published an advertisement in the New York Times positively stating that they owned but "one-sixth" of the capital stock, acquired several years ago at private sale, and that they had never sold or traded in a share of that stock since. The advertisement was a cunningly worded subterfuge in that their holdings, while only one-sixth of all issued stock of both kinds, were in reality over one-half of the issued common stock, which alone carried administrative power. At no time had they owned any of the preferred issue.

One year later, in November, 1912, the same rumors of ownership arose and this time the Guggenheims sent out an official statement to the press containing the subject matter of the advertisement published the year before. By this time the suspicion had grown to a moral certainty, however, and but few financial editors in the city cared to assume responsibility for publication of the item.

A few weeks ago, when the matter of concealment of Federal control in listing American Smelters Securities Company was considered by the New York Stock Exchange as the result of charges made by minority interests, Edward Brush, vice-president of the company, stated that the Federal holdings were out of the hands of the Guggenheims for a few weeks or months about the time American Smelters Securities was listed. The books however, show no such transfer and it is evident either that this statement was a deliberate falsehood or that M. Guggenheim's Sons misled the public in their advertisement and subsequent official statement. There is no escape from such conclusion and it is illuminating as proof of the fact that downright deceit is no hindrance to consummation of some plans of high finance.

The manipulation of Federal to high levels and its consequent meteoric drop, occasioned by cessation of common dividends, doubtless resulted in an appreciable clean-up for the inside interests. This object having been attained, official "bear" stories were circulated concerning the early exhaustion of the mines and quotations receded to the present neglible level. Last year, presumably for the benefit of the Ways and Means Committee of the House of Representatives, which a few months later was called upon to consider the metal tariff schedule, dividends on preferred were dropped to 6% and have since remained at that figure. A surplus of $1,300,000 was accumulated in Federal's exchequer and that sum is now being used to perpetuate the Guggenheim hold upon the lead industry at the expense of Federal. It must be remembered that the twenty-one year contract provides that every property henceforth acquired by Federal must ship its product under its provisions.

A NEW TRUST "RICHMOND."

As agent in their campaign to acquire more properties for themselves, in the name of Federal, with Federal money, and of which all profit apart from preferred dividends was to accrue to their smelting pocket, the Guggenheims selected Harry L. Day, part owner of the Hercules mine, near Burke who was made president and general manager of Federal last summer at an annual salary of $15,000 and expenses. Day had been the most rabid assailant of the Guggenheims and their methods in former days and is a brother-in-law of Ed Boyce, former president of the Western Federation of Miners, now capitalistically inclined as a marriage-owner of Hercules, but in the earlier days known as one of the most dangerous agitators in the labor troubles that led up to the assassination of Governor Steunenberg by Harry Orchard.

In 1902, Day and his partners in an effort to circumvent the trust had purchased an interest in the Selby smelter at Vallejo Junction, California. Subsequently the Guggenheims acquired this interest for approximately $400,000 and secured a ten-year contract for Hercules ore at a lead settlement basis of flat New York quotations, less 60 cents per hundred pounds. This contract would have expired this year and it looked as if it might slip through the Guggenheim fingers into those of the International Smelting & Refining Co., which had recently entered the lead-smelting field. To prevent this the Guggenheims voluntarily cancelled the contract last year, making a new one providing for lead settlement at flat New York quotations with freight and treatment rate of $14, using as a further lever sufficient flattery to induce Day to accept the position of president and general manager of Federal.

Since the latter assumed the reins of trust power properties have been purchased or contracted for to the tune of over $1,000,000 and it is rumored that several other big producers are being bargained for. Should such prove to be the case large additional sums would be needed to finance the undertakings and the Guggenheims will then be forced to go to the public with an additional issue of Federal stock, as, unless the new mines are acquired through Federal, it would be impossible to bring their product under the present twenty-one year contract.

MILLIONS IN PROFIT.

The importance of the output of Federal in its bearing upon the Guggenheim domination of the lead industry of the United tSates can best be understood by study of the following figures of production from 1906 to 1912:

Year	Tons Ore Shipped	Tons Lead	Federal per cent of U. S. Production
1906	130,855	63,029	18%
1907	130,373	59,746	16%
1908	 93,811	43,988	19%
1909	....122 764	56,904	15%
1910	107,826	48,155	12%
1911	118,315	50,875	12%
1912	118,734	50 936	12%
Total	..822 678	373,633	Av 7 yrs 15%

On total shipments of 822,678 tons crude ore and concentrates it is evident that the smelting trust has collected no less than $6,581,424 in treatment charges at $8 per ton. The average price of lead during the period was $4.71 per hundred pounds, while by the provisions of the present contract, Federal received but $3.99 per hundred pounds. This left an unjust profit of 72c per hundred pounds for the smelting trust, a sum equal to $5.25 per ton of ore and concentrates shipped, assuming that such shipments contained 40% lead during the entire term. With total shipments of 822,678 tons it will thus be seen that the Guggenheims have benefited to the extent of $4,319,062 above and beyond a fair price for treatment. Under a presumably fair treatment charge and an unjust tax of $5.25 per ton the total amount yielded to the Guggenheims in seven years was no less than $10,900,486. This is apart from any possible unfair profit derived from diversion of shipments from the long haul to the short haul point of reduction. If all shipments during the seven years had been sent to Helena instead of to Colorado points another clear profit of $3,907,720 would have resulted to the smelting company. Just how much of the product has been so diverted it is impossible to ascertain except through the Department of Justice or Interstate Commerce Commission. In all probability these facts will be available within a comparatively short time. Omitting this item entirely, however, it can readily be seen how valuable the output of the Federal is to the controlling interests. The ordinary man may also understand something of the methods by which the Guggenheims have built themselves up to the controlling factor in the lead industry of the United States.

MINORITY TAKES ACTION.

In the fall of 1912 a small coterie of stockholders decided to make a stand in their own behalf and in that of others similarly situated. The Guggenheims were approached with a friendly request to revise the contract in simple justice to those who had invested in good faith, but the emissaries were laughed at for their pains and so suit was started in the New York Supreme Court. The complaint sets forth the salient facts as above stated, asks for an annulment of the contract upon the allegation that it is fraudulent, an accounting for approximately $2,000,000 for sums wrongfully taken since the twenty-one year contract went into effect and an injunction prohibiting Federal from acquiring new mines to be operated under the present contract.

While every artifice will be used by the trust to prevent the matter coming to trial, the outcome will be watched with great interest as one of the most important mining cases filed in many years. The rights of minority interests have been clearly defined in a long list of widely-distributed decisions and those in charge of the fight firmly believe that this time the Guggenheims will be brought to time.

THE LESSON OF FEDERAL.

The lesson to be gleaned from these facts by the investing public is that the losses sustained by Federal stockholders are in no wise due to the failure of its mines to respond handsomely to development. In fact if Federal (which the Guggenheims control) were permitted to ship its product on the same lead settlement basis as is granted by the trust to the Hercules mine of President and General Manager Day (which they do not control), the present earnings would be at the rate of over $1,750,000 a year. This would provide full 7% on $12,000,000 preferred stock, 10% on $6,000,000 common stock and still leave a surplus of over $300,000 for contingencies. At present settlement rates its earnings are approximately $1,000,000 a year, of which $840,000 is due to preferred stockholders.

Unfortunately for the general good of the great mining industry, which adds two billion dollars a year to the wealth of the nation and employs many hundred thousands of men, the experience of Federal stockholders is used as an argument against the industry. It cannot justly be so construed and rather proves that mining, where properly and honestly conducted, offers returns that cannot be duplicated in other lines of endeavor. It should teach the investing public that the honesty of those in control is of as much importance as the value of the mines upon which their securities are based and that, in the absence of square dealing, innumerable methods may be devised to cheat them of the reward which is their rightful due.

Comparative Efficiencies in Use of Compressed Air

By G A. DENNY.

I have been invited by the Council to contribute a paper to the Institute, which may serve as a type of the communication which the Council specially desires to obtain, namely, short papers dealing with subjects particularly adapted for discussion.

My aim in the following note will be, I believe, perfectly patent to my colleagues. No attempt is made to support by more than generalizations, the statements made, the object being to supply a skeleton around which useful and informing discussion may build a body of opinion and experience, which will be instructive to us all.

In choosing the subject of compressed air transmission, I have especially in mind, that it is one in which we are all interested, and all have more or less costly experience. Moreover it is a branch of our mechanical operations—invaluable and essential though it may be despite its deficiencies,—which offers an excellent target for the critic purposely seeking only its misdemeanours, in order to invite discussion in its defence.

In a similar spirit, but from an opposite standpoint, the benefits of hydraulic transmission are touched upon, with the intention of provoking critical discussion.

The problems of air compression and transmission are as numerous as they are complex. Pressure, temperature, and volume, have an interchangeability of relationship, which whilst fully covered by theoretical formulae, are most elusive in habit, and unsubmissive to theoretical demands in every day practice.

Our definitions of free air, generally apply to pressures of one atmosphere at sea level, or 14.7 lbs., and 60 deg.,

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temperature F. But what infinity of variation is there from those bases. Every latitude, every elevation, almost all specific localities, have their own peculiar involutions of volume, temperature and pressure, each new combination giving rise to relationships, singular to themselves. Absolute temperatures, must be considered in all cases, whether dealing with free or compressed air, as weight and pressure will vary in accordance with the absolute temperature of the original volume, the latter also suffering variations in conformity with the rise or fall of the absolute temperature. At 30 deg., or 491 deg. absolute, a cubic foot of dry air at sea level and average atmospheric pressure weighs .0811 of a lb., and the volume of 1 lb. at this temperature and pressure, is 12.336 cub ft. At 90 deg. F.—absolute 551 deg.—a cubic foot weighs .0722 lbs., with a volume for 1 lb. of 13.853 cub. ft. At 200 deg.,—absolute 661 deg.,—a cubic foot weighs .0602 lbs., with a volume of 16.907 cubic feet.

The relationships of temperature, pressure and volume have been succinctly stated as under:

1.—The absolute pressure of air, varies inversely as the volume, when the temperature is constant.

2.—The absolute pressure varies directly as the absolute temperature, when the volume is constant.

3.—The volume varies as the absolute temperature, when the pressure is constant.

4.—The product of the absolute pressure and the volume is proportional to the absolute temperature.

When air is compressed, an increase of temperature takes place but not proportionate to the pressure, nor will air which is taken into the cylinder at zero, have a temperature increment similar to air which is taken in at 100 deg. At two atmospheres gauge pressure, for instance, air of an initial temperature of zero, will have risen to 170 deg., whilst air of an initial temperature of 100 deg., will have risen at the same gauge pressure to 320 deg. In the higher pressures, the rate of temperature increase is much lower. For instance, air of an initial temperature of 100 deg. will only rise about 20 deg. between gauge pressures of 21 and 23 atmospheres.

The importance of the question of original temperature of the free air, cannot be overestimated, since that volume of free air which we take into the cylinder, is in the last resort the unit we have to count upon for work. If the air is so heated at the moment compression begins, that its volume is increased by say 20 per cent, we are actually reducing the capacity of our machine—from a basis of cool air—to that degree, and have to exert as much power for the compression of an 80% cylinder charge, as would be required for an 100% charge of cooler air.

Even when every precaution has been taken to provide the coolest and cleanest supply of air available, to the compressor, we still have the heated condition of the air cylinder itself to contend against, which causes an immediate rise in the temperature of the entering air, reduces the volume, and deprives us of a fixed, but unascertainable amount of eventual energy. No determination has ever been made of the exact rise in temperature of the entering air, in any given instance, nor does it appear likely from the nature of the case, that it will ever be accurately fixed, as the indicator gives us no information on the point.

The safest way to minimize losses in this direction is to lead the air into the cylinders from cool places, in channels or conductors of wood or concrete, or other material which is a bad heat conductor or radiator.

Having the air in the cylinder, we now proceed to reduce its volume and increase its pressure. If this could be done without creating heat, the air would conform to the ordinary law of gases, namely, that its volume would vary inversely to the pressure, and a diagram of the operation in the cylinder would give us an isothermal compression line. In that case, (if it were possible), assuming the air to be originally at one atmosphere pressure, sea level, and 60 deg. Fah., and that we have compressed it to 80 lbs. gauge pressure, the original volume of air taken at 1, would be reduced to .1552, and the mean pressure per stroke would be 27.33 lbs.

It is well to keep these ideal conditions in mind, in order to see how far short of them our actual practice falls.

In the same conditions as above, and assuming no air cooling, the volume of air after compression is .267 of the original unit, and the mean pressure per stroke 36.6 lbs. That is to say, in practice, where no cooling arrangements exist, we require 34% more power for the air compression, because the volume of air has been increased by heat. In the best practice, with all the cooling arrangements possible, or practicable, a result somewhere between the two figures is attainable. The methods of air cooling that have been tried are three, namely:

1.—Water jacketing of the cylinders.

2.—Water spraying in the compressing cylinder.

3.—Cooling in a special apparatus between the compression stages.

As we are treating at the moment of only single stage compression, the first two are all to which we need refer.

Of the two systems under notice, that of water-jacketing, is the one almost universally adopted. In this system however, the cooling effect is at best, very ineffective, since the inner surface of the cylinder can only be slightly cooled, and can therefore only effect a film of adjacent air, leaving the large bulk of air, in the central portion of the cylinder almost untouched. For this reason cylinders of small diameter must allow of better cooling than large cylinders, but other mechanical considerations will outweigh this advantage, where a large output is required. The practice of water spraying in the compressing cylinder has almost been abandoned. The practical objections to it are:

a. that it produces very moist air, which freezes in expanding, and blocks the exhaust passages of pumps, etc., with ice;

b. that it necessitates very large clearances in the cylinders and restricts operations to comparatively low piston speeds;

c. that it gives rise to serious difficulties in the lubrication of the cylinder; increases friction; induces excessive cylinder wear, and reduces efficiency.

If it were possible to utilize the heated air immediately, without loss in volume due to cooling, we should not have to deplore the large power losses represented by the difference between isothermal and adiabatic compression. But in practice the air after compression is discharged into receivers and pipe lines, and returns more or less to its original temperature, with a corresponding shrinkage in bulk, and with lessened energy possibilities Attempts to restore in part the lost energy due to volume shrinkage, are made by reheating the air, near the point at which it is to be used, but it may be said in general, that no reheating apparatus finds a place in mining installations, and therefore no recovery of the loss due to adiabatic compression is made.

It is perhaps well to emphasize the fact that an air compressor has two quite separate and distinct functions to perform, namely:

a. That of increasing the pressure of the air from a pre-existing to some determined pressure;

b. That of discharging the air of a determined pressure into the mains.

We have seen that the admission of the maximum volume of cooled air into the cylinder is the first desideratum in the process of increasing pressure, since the capacity of the machine is reduced, and power is wasted in proportion to the temperature of the air above a certain practicable minimum.

Similarly with the discharge. As the volume of air, owing firstly to the admission of warm air and secondly to the heat generated by the compression, will have greatly increased, the power required for its discharge will be proportionate to the bulk of air discharged. If at the moment compression begins, the air has a temperature of 60 deg. and if it were compressed to 80 lbs. gauge pressure, its final volume would be .1968 of the original volume, if compressed isothermally, or .3144 if adiabatically compressed, and the temperature in the latter case would be 375 deg. In this instance, the volume of air after compression has a bulk of 60% greater than it would have had if the air had been kept down to a temperature of 60 deg. Again if the air at the moment of compression had a temperature of 80 deg. or 20 deg. higher than before, and were compressed to 80 lbs. gauge, its final volume would be .1552 isothermal, or 267 adiabatic, and the temperature in the latter case would be 432 deg. Here the air after compression has a bulk of over 71 per cent greater than it would have had, could the isothermal conditions have been realized. In order to discharge the increased bulk of air therefore we require over 71 per cent more power than would be necessary if the temperature of the air could be retained at 80 deg. F. throughout the operation.

The horse-power required to compress 1 cub. ft. of free air to a pressure of 80 lbs. adiabatically is .184 of a h. p., and the power necessary for the discharge of 1 cub. ft. of the compressed air into the receiver, is 1.85 h. p.

The important practical considerations in the figures just given are that:

a. The air is not in a condition to be applied to our purposes, until we have expended a considerable amount of power in the reduction of its volume.

b. The power required for the discharge of the air is to a large extent wasted, because in the conditions we have taken, we must discharge a bulk of 1.71 units of heated air, which after cooling, becomes only one unit available for power.

We may examine further, in the light of the foregoing statements into the pneumatic efficiency of the compressor.

If a normal diagram from a single stage compressing cylinder be examined, it will be seen that it is exactly the opposite of a steam cylinder diagram; steam admission being represented by air delivery; steam expansion by air compression; and steam compression by the air re-expansion line. An interpretation of a normal diagram from a single stage machine compressing free air at 60 deg., to 80 deg. gauge, will show that the work done may be divided as under:

a. Work done in raising air pressure;

b. Work done in excess due to heat;

c. Work done in expelling compressed air to the receiver.

These operations may be expressed numerically as under, having reference to one stroke of the piston:

1.—.734 of the stroke used, at a mean effective pressure of 20.5 lbs. for bringing the air from atmospheric pressure to 80 lbs. gauge, or .734 x 20.5 equals 23.911 stroke pressure units.

2.—The excess bulk due to heat is 71.4 per cent, and the volume of compressed air at 60 deg. is .1552 of the original volume. Therefore the excess work done due to heat is .714 of .1552 or .1108 of the stroke, at the delivery pressure of 80 lbs., or .1108 x 80 equals 8.864 stroke pressure units.

3.—The part of the stroke which furnishes us with power in the receiver, that is for our purposes, the really useful portion of the stroke, is that proportion of it which is required to expel the volume which the compressed air will occupy when cooled, namely .1552 stroke working against a pressure of 80 lbs. or .1552 x 80 equals 12.416 stroke pressure units.

We thus have for the total stroke an aggregate of 36.327 stroke pressure units.

The only portion however, as before stated which provides us with air at working pressure is that referring to the discharge, namely 12.416 units, the remainder being losses in bringing the air up to pressure, and in heat. That is to say, we get a useful result only from 34 per cent of the power put into the work, and 66% may be reckoned as loss. Apart from, and in addition to this loss, are the losses inseparable from the machine, as such. To begin with, the volume of air compressed is never the full contents of the cylinder, since there is clearance to be reckoned with, and lateness in reaching full atmospheric pressure, on the admission side. The mechanical losses may be put down at 10% for the friction of the machine, 10% for losses due to increased temperature of the air after admission, 10% for losses due to clearance, leakage, valve resistance, etc. This leaves 70% only available for air compression, and of this available amount of power, we have seen that only 34% does useful work. Then 34% of 70% or 23.8 per cent is all the useful effect we get, expressed in terms of air delivered to the receiver.

We have so far dealt with figures relating to single stage compression, and the question now arises, as to what extent the losses in single stage practice will be minimized by double stage compression.

The sole object of double stage compression is of course the avoidance to the greatest extent practicable, of the heat losses, by cooling the first stage air, before it enters the second stage cylinders.

Below are the figures so far as they relate to temperatures, of an actual test. The test was made upon a horizontal cross-compound two-stage compressor, with suction air valves mechanically operated, delivery valves of automatic design to close in equilibrium, air cylinders water-jacketed both on barrel and ends, intercooler between the cylinders.

Temperature of air at intake...	81.6 F.
Temperature of air, low pressure delivery	252.1 F.
Temperature of air, intercooler..	148.2 F.
Temperature of air, high pressure delivery	262.4 F.
Pressure of air in intercooler...	34 lbs.
Pressure of air in receiver......	91.7 lbs.

It is interesting to note the effect of the jacket cooling on the air of the low pressure delivery. The final temperature of the air, without any jacketing would be 310 deg. F. therefore the jacketing has lowered the temperature only 58 deg. and has affected the volume of air therefore, to a very limited extent.

If isothermally compressed, the volume of air would be over 30 per cent less than the adiabatic volume, showing that the water jacketing in this case has given far from an efficient result.

Turning now to the intercooler, we find that it lowered the temperature of the air by 104 deg., but still the air had a temperature of 148.2 deg or 66.6 higher than the original intake, and the capacity of the delivery cylinder would be prejudiced and its useless power increased proportionately to the excess volume occupied by the heated air. The complete cooling which is often claimed in the intercooler, was therefore, far from being realized in this instance.

It is still a matter of opinion amongst many of the best informed engineers on this subject, whether for ordinary working pressures say up to 80 lbs. gauge, there is any advantage in double stage practice. In a booklet published by a well known maker of compressors, the following statement is made:

"The very processes of compounding may too easily lead into mechanical difficulties which in the aggregate, may not only counterbalance the gain by compounding, but may actually swing the balance in the other direction, and result in a machine of lower efficiency, as compared to the single stage machine of the best class."

Following upon the losses incident to the compression and delivery of compressed air to the receiver, we have the losses in the pipe lines and in the machines which utilize the air for power purposes. Theoretically the losses in

air mains should be very low, given perfect conditions, and not great distances, but in ordinary mining practice, there is no question that they are frequently very high. A test made under my own supervision in a large South-African mine, showed that the receiver and pipe line losses, amounted to 11.5% of the indicated horse power of the engine. This loss is of course made up mainly of two components, friction and leakage, in what proportions could not be determined. It is probable that 10 per cent would be a fair figure to adopt for leakage and friction in the ordinary mine installation.

We have now to consider for a moment what efficiencies are obtained from compressed air in ordinary mine usage. Rock drilling and pumping are perhaps the principal applications of compressed air power in mines, though it is used for a variety of other operations such as hoisting, signaling, ventilating, etc.

Considered as an engine, the ordinary rock drill is not an efficient machine, since it uses air at full pressure throughout the piston stroke. The average drill developes about 1.5 h. p In order to obtain this power, it has been proved by test that the steam engine working the air compressor must develop anything from 25 to 32 h. p. so that the over-all efficiency of the system in terms of power at the rock drill bit is in the neighborhood of say .5 per cent It seems incredible, that rock drilling operations are so inefficient, but it is nevertheless true, that the above rate is probably representative of the large majority of mine installations.

Pumping by compressed air is largely resorted to in mines because of its convenience, or expediency, or both. On a test made under my own supervision on a large mine, in which all the auxiliarly pumping was done by compressed air, using seven pumps, the efficiency of the pumps as a whole, on the original power put into the compression, worked out at between 9 and 10 per cent. The pumps used were the ordinary steam pump, in which all losses due to clearance, and unsuitability for the pressure used, were greatly exaggerated. Still they represent average practice in this respect, and the losses, similarly to those occurring in rock drilling, are so high as to seem almost incredible.

I have said enough I think about the losses incident to the generation and use of compressed air, to stir up a vigorous defence amongst its champions, from which we must all benefit.

In contradistinction to the losses involved in an air compressing and transmission system in its application to rock drilling I will now state briefly the features and advantages of hydraulic transmission for a similar application.

The outstanding difference between air and water from the point of view of power development and transmission is, that water is non-elastic.

Unimportant as this apparently simple difference is on first view, it will be found on closer examination to describe practical immunity from nearly all the heavy losses incident to air transmission and compression, as under:

1.—There is no initial capacity loss due to increased temperature after admission to the working cylinder.

2.—There is no complicated and expensive mechanism required in developing power, whether the head be gained by artificial or natural means, and there are no large friction losses.

3.—There are no heat losses.

4.—No power is required for the preliminary compression, and in consequence, instead of suffering the tremendous losses incident to the process of bringing the water up to working pressure, all the power is utilized in discharging it into the pressure mains The importance of this is better appreciated, when we state that one unit volume of water at 1,000 lbs. pressure allowing 5% for cylinder and other losses, would transmit 95,000 volume units of pressure, whilst one unit volume of air compressed to 80 lbs. gauge, owing to the small percentage of the stroke available for delivery to the mains, would not transmit to exceed say 2,000 volume units of equal pressure.

5.—There are no clearance losses.

6.—With extremely simple mechanism very high working pressures from 500 to 1,000 lbs. and upwards per square inch may be developed

7.—At working pressures such as mentioned in the previous paragraph, the transmission losses are negligible, and the volume of water required, and the hydraulic mains, are very small.

The over-all efficiency of a hydraulic system, in terms of power delivered to the hydraulic drills would not be less than 80%. The efficiency of the drill would range, according to the type employed from say 60% to 80%. Therefore the over-all efficiency of the entire system would not be less probably than 50%.

On the same basis, the efficiency of a steam-driven compressed-air system will not exceed 6%.

Mexico is a country of water powers, and potential hydraulic transmission projects In view of the great advantages offered by hydraulic transmission and hydraulic drills, it is greatly to the interest of the mining community, to make most careful enquiry into the possibilities of adopting it.

Where natural fall is not available for pressure purposes, a pump of comparatively simple and efficient type is all that is required to develop any working pressure desired.

COPPER FROM SCRAP

C. L. Parsons, in Bulletin 47, of the United States Bureau of Mines, in touching on the recovery of copper from scrap, says that the junk dealer is performing an important service, for all scrap containing copper is eagerly sought, and the copper removed. Copper-wire scrap by the thousands of tons is annually gathered, the insulation, if present, burned off, and the whole simply remelted, poled, and cast again into wire, or into bars or ingots for redrawing. Brass, bronze, coppered tin, etc., of unknown composition, when gathered in endless variety of kind, such as bases of electric lamps, brass and copper turnings and shavings, cartridge shells, broken and battered household goods, old pipe, brass tinsel, moulding sand from brass foundries, concentrates of ashes from brass furnaces, copper paint sludge, and flue dust, much of the miscellaneous collection being briquetted, is treated direct in a copper blast furnace. From this furnace is produced an impure alloy containing about 86 per cent copper, which goes to the blister furnace to make casting copper. In the smelting the zinc, iron, nickel, tin, antimony, and lead present are entirely lost, either in the fume or in the slag. Practically all copper-bearing junk is treated directly to the reverberatories When trimmings or turnings of some special alloy of known composition are obtained in sufficient quantity, they are usually remelted direct with more fresh material of the same composition, generally for re-use in the same works, or the same class of works, from which they were derived, although this kind of material, in a sense, does not deserve to be classed as junk at all. However, a single smelter near New York recovers as much as 10,000,000 lbs. of copper a year from true junk, and many other works throughout the country are resmelting such material.

The Boston Financial News professes ignorance concerning the apathy of the speculative and investing public in the copper stocks. There are none so blind as those who refuse to see. When publications like the Financial News cease to parade as truth statements concerning mines and mining promotions which common sense should suggest to them are unbelievable, they may be able to discern the reason why the public holds aloof.

PRECIPITATION BY ALUMINUM DUST

By E. M. HAMILTON.*

It is hardly necessary to begin this article with a description of the material being treated because the composition of the ores of the Cobalt district has been dealt with by other writers at various times, but before proceeding to the subject of aluminum precipitation at the mill of the Nipissing Mining Co., it may be interesting to explain the circumstances that led up to its adoption.

In the course of preliminary experiments on the ore to find out the conditions of extraction of the silver by cyanide, it was noticed that the solutions, after being precipitated with zinc and used again, rapidly lost their dissolving efficiency. This phenomenon is not uncommon, but I have never before seen an instance where the deterioration was so marked.

At first I thought the trouble might be due to gradual accumulation of reducing agents in solution, because when tested with permanganate, as suggested by Clennell, it displayed considerable reducing power. I do not, however, consider that reducing power, as indicated in this way, is necessarily any criterion of the dissolving efficiency of a solution, because substances may react by the permanganate method as reducers, though they may not have power to abstract oxygen from the solution (e.g., KCNS) and if they do not absorb the dissolved oxygen from the solution, they cannot be classed as reducing agents in the sense of being detrimental to extraction on that account. Still, I thought it a point for careful investigation in this case, and tried aeration of the solution even to an exaggerated extent, and also the addition of hydrogen peroxide and oxidation by electrolysis, but all without effect in improving the dissolving power of the solution. It was then obvious that the trouble was to be looked for elsewhere.

ZINC FOULED THE SOLUTION.

The first thing to come under suspicion was the presence of zinc, seeing that a fresh solution that did not contain zinc gave a good extraction, whereas the same solution after the zinc precipitation gave a bad one, and after a second precipitation, a worse one. By way of following up this suggestion, three extraction tests were made under similar conditions on a sample assaying about 30 oz. of silver per ton. **A** was treated with precipitated stock solution, with the analysis shown in the following table.

B was treated with new solution and **C** with stock solution as in Table 1, but after most of the zinc had been precipitated by sodium sulphide. The ore was ground to pass a 200-mesh screen, and 48 hr. agitation was given with a solution of 0.2% free cyanide.

The residues assayed, **A**, 6.55 oz. Ag; **B**, 2.31 oz. Ag; and **C**, 3.70 oz Ag. This result pointed to the zinc as being the offender, and following this indication, two tests were made on another sample of ore, one being treated with a plain freshly made cyanide solution, and the other with a solution (also freshly made), to which 0.1% of zinc had been added. The residues after 48 hr. were: **D**, 4.28 oz. and **E**, 8.19 oz per ton.

ANALYSIS OF SOLUTION USED IN TEST.

KCN (free)	0.09 %
Alkali (protective), in terms of NaOH	0.13 %
Ag, per ton of solution	0.80 oz.
Zn	0.113 %
KCNS	0.069 %
Sb	0.0025%
Cu	0.021 %
As	0.021 %
Fe	0.007 %

It was not at all apparent why the zinc should act in this way, because as a rule I have found that the presence of zinc in solution has no appreciable effect on extraction. On looking through the list of substances in the foregoing analysis, the antimony and arsenic suggested themselves as being the most unusual, and since the amount of the latter was 10 times that of the former, the arsenic was selected as being a possible conspirator.

ARSENIC ALSO A HOSTILE INFLUENCE.

Another series of experiments was thereupon made in which **F** was treated with new solutions; **G** with new solution to which 0.021% arsenic was added; **H** with new solution to which 0.1% zinc was added, and **I** with new solution to which 0.021% arsenic and 0.1% zinc were added. Upon assaying, the residues ran: **F**, 3.22 oz. Ag.; **G**, 4.90 oz.; **H**, 4.78 oz., and on **I**, 7.05 oz. silver per ton.

All these results seemed to point to the fact that the degeneration of the working solutions was due to the use of zinc as a precipitant in the presence of arsenic, and accordingly some other method of precipitation was sought. There was a possible choice of at least three other methods: electrolysis, sodium sulphide and aluminum.

As I have had long experience with electrolytic precipitation of cyanide solutions, and am well aware of its weak points, it was considered to be a remedy of last resort, though a possible one. Sodium sulphide would be a very suitable precipitant for silver solutions, except for two drawbacks. The first is that complete precipitation is not obtained without using an excess of the reagent, which would then have to be removed by a lead compound, the alternative being a tailing solution too high in silver to form an effective residue wash. The second drawback is the recovery of the silver as a sulphide instead of in the metallic state. Attention was therefore turned to aluminum.

ALUMINUM PRECIPITATION SUGGESTED BY MOLDEN-HAUER.

As far back as 1893, Carl Moldenhauer patented the use of aluminum as a precipitant for gold and silver from cyanide solutions. He says in his specification: "Zinc has heretofore been employed in practice by preference in precipitating gold from the cyanide solutions obtained by leaching auriferous ores. The employment of zinc for this purpose is found, however, to be attended with serious disadvantages. Now, I have discovered that aluminum can be employed for this purpose in place of zinc without the disadvantages attending the use of the latter. While zinc forms a combination with the bound or free compound of cyanogen and alkali contained in the cyanide solution, aluminum separates the gold very quickly from the cyanogen solution without entering into combination with the cyanogen, but simply reacting with the caustic alkali which is present at the same time. By the action of aluminum, the cyanide of potassium employed for leaching the gold out of its ore is regenerated, which is not the case when zinc is employed. But the zinc does not confine itself to entering into combination with the cyanogen compounds of the gold, but also acts upon the free cyanide of potassium contained in the solution, so that a great part of the latter is consumed, but this is not the case when aluminum is employed. These results are of the greatest importance when the solution separated from the gold is to be employde in subsequent gold-extracting operations, as the whole of the cyanogen in the regenerated and liberated cyanide of potassium is enabled to renew its action, but the lyes resulting from the em-

* Nipissing Mining Co., Cobalt, Ont., in Engineering and Mining Journal, May 10, 1913.

ployment of zinc cannot be employed with the same advantage in subsequent operations of the gold.

"Numerous attempts have been made to regenerate the zinc, but are found to be inconvenient and costly. It is consequently evident that an important saving in cyanide of potassium is obtained by the employment of aluminum."

ALUMINUM FORMS NO CYANOGEN COMPOUND.

The inventor does not appear to have developed the idea on a practical scale, but it is worthy of more attention than it has received, because, as he points out, owing to the fact that aluminum does not form any compound with cyanogen, not only is the whole of the cyanide recovered which was combined with the precious metals, but also the additional loss of cyanide by direct combination with the zinc is avoided. In the case of solutions strong in cyanide the latter loss may be considerable.

Some may dispute the ground I take when I count as lost the cyanide that remains combined with zinc, because it is often stated that the double cyanide of zinc and potassium is almost as efficient for dissolving purposes as the simple cyanide. My experience is, however (at any rate in the case of silver ores), that the reading obtained by the use of KI indicator with excess of caustic, is worthless as a measure of the dissolving power of a cyanide solution, the efficiency being for practical purposes proportional to the "free" cyanide reading obtained by stopping at the first faint opalescence without the use of KI indicator.

CAUSTIC ALKALI NECESSARY.

The fact that aluminum does not replace the precious metals in the cyanogen compound, renders necessary the presence of a caustic alkali, the reaction probably occurring theoretically thus:

6 $NaAgCY_2$ plus 6 NaOH plus Al equals 6 Ag plus 12 NaCy plus 2 $Al(OH)_3$,

the aluminum hydroxide at once dissolving in the excess of caustic to form sodium aluminate,

2 $Al(OH)_3$ plus 2 NaOH equals $Na_2Al_2O_4$ plus 4 H_2O.

If this explanation be the correct one, it should be possible to make one part of aluminum precipitate 12 times its weight of silver, but in practice I have so far not been able to reach this proportion. Perhaps in the case of low-grade solution, when caustic and aluminum are both present in excess, as must usually happen in practice, the following may more nearly represent what actually goes on:

2 $NaAgCy_2$ plus 4 NaOH plus 2 Al equals 4 NaCy plus 2 Ag plus $Na_2Al_2O_4$ plus 4 H.

In this case, one part of aluminum would precipitate four times its weight of silver, and this figure approaches more closely the actual proportion I have found in practice, which is about three of silver to one of aluminum. For zinc precipitation Clennell gives the following equation:

$NaAgCy_2$ plus 2 NaCy plus H_2O equals Na_2ZnCy_4 plus Ag plus H plus NaOH;

and according to this, one part of zinc will precipitate only 1.7 times its weight of silver. This zinc reaction is also worthy of comparison with that of aluminum from the fact that two molecules of free cyanide appear to be used up in addition to the two molecules of cyanogen in combination with the silver.

The consumption of cyanide by direct combination with the zinc is illustrated by Clennell as follows:

Zn plus 4KCy plus 2 H_2O equals K_2ZnCy_4 plus 2 KOH plus H_2.

The indications then would go to show that quite apart from any detrimental action that zinc may have upon extraction of the precious metal from its ore, the substitution of aluminum should be, on its own merits, a valuable improvement, and I shall try to show later on that this proposition is borne out in practice.

ALUMINUM SUCCESSFULLY USED AT DELORO, ONTARIO.

Although twenty years since Moldenhauer so ably explained the advantages of aluminum over zinc, the commercial application of the process is almost unknown. In 1893, H Forbes Julian experimented with it (cf. Julian and Smart, "Cyaniding Gold and Silver Ores"), but does not seem to have met with any practical success. He first used vertical aluminum plates set ¾ in. apart in a standard precipitating box, but, owing probably to lack of surface, the result was unsatisfactory. Afterwards he used shavings, which showed a great improvement, but in time the metallic surfaces became coated with alumina, which impeded precipitiation to a prohibitive extent. He was unable to overcome the difficulty, and finally abandoned the attempt to make use of the process.

The first instance I have been able to find of its successful commercial application, was at the Deloro smeltery, Ontario, where it was introduced by Prof. Kirkpatrick for dealing with a rich cyanide liquor resulting from the treatment of some special products. Warned, probably by Julian's failure, and having before his mind the wide use of zinc dust, he conceived the idea of applying the aluminum in the form of a powder, by which means he overcame the obstacles encountered by Julian, and made the process a perfect success.

In 1910, Kirkpatrick took out a patent for a special tank designed to effect a proper mixture of the dust with the solution. The difficulty in the use of aluminum dust is to get it to sink, because it is not easily wetted, and even when wet, tends to rise to the surface of liquid through the buoyancy imparted by minute hydrogen bubbles, unless a violent agitation is maintained. Kirkpatrick overcomes this trouble by using a tank having a vertical shaft at its center, carrying one or more screw propellers, which, when revolved by a suitable power connection, forms a vortex in the center of the solution to be precipitated.

A sufficient quantity of the dust is then added, and as it spreads out on the surface, the vortex sucks it down to the bottom, whence it passes outward towards the periphery and up again to the surface, again to be sucked down at the center. This motion is maintained until precipitation is complete, when the whole charge is pumped to a filter press for the separation of the precious metal. The same process has been in use at the O'Brien mill in Cobalt for three years or more in precipitating the working solutions in the cyanide plant and has apparently given entire satisfaction

RATE OF PRECIPITATION DEPENDS ON VIOLENCE OF AGITATION.

Before finally adopting aluminum as the precipitant for the mill, a series of laboratory tests were made, which showed that not only was the combined cyanide liberated, as indicated by titration, but also that no deterioration of the solvent power of the solution was apparent after using and precipitating a number of times.

The above mentioned tests showed, among other things, that the rapidity of precipitation depended to a large extent on the violence of the agitation used for mixing and that whereas a charge shaken up briskly in a bottle would have its reaction completed in about two minutes, a large charge stirred up in a tub with a stick needed from 10 to 15 min., other conditions being equal. It, therefore, seemed that it should be possible to get away from the intermittent system represented by the Kirkpatrick method and work more on the lines of the continuous zinc-dust precipitation. The appliances for the latter process, making use of the Merrill machinery, had already been installed, including clarifying press, dust feeder, emulsifier and two triangular presses. It was evident, however, before making a start, that more time for contact would be required than had been provided for the zinc dust by the 200 ft. of pipe line between the emulsifier and the press It was also evident that it would be difficult

to feed the aluminum dust, even as an emulsion, into a stand-pipe connected with the pump suction, because, as already explained, the dust is difficult to wet, and even after it has been wetted, it will soon tend to rise to the surface and float as a thick scum unless a brisk agitation is maintained. If it were fed into a stand-pipe it would collect on the surface of the liquor and gradually fill the pipe instead of being drawn down into the current flowing to the pump. Therefore, the following modification of zinc-dust practice was adopted and was found to answer admirably.

MODIFIED ZINC-DUST APPARATUS USED FOR ALUMINUM.

Referring to the accompanying illustration, 1 is the pregnant solution storage tank from which the solution passes to a triplex pump and thence to the clarifying press 4. The tank 5 is now superfluous, having been installed as a storage for the zinc-dust process, but the clarified solution falls into it as previously arranged, flowing out again at once by the launder 6 into tank 13. The feeder 7 for the aluminum dust, which discharges directly into the stream of solution, flowing in the launder 6. The emulsifier supplied for zinc dust has been eliminated as not serving any useful purpose in the present process. The launder is fitted with a cover and has a flap of canvas hanging over the discharge opening to avoid loss in dusting. Tanks 13 and 14 are about 6 ft. deep by 5 ft. in diameter, and have a central revolving shaft to which are bolted vertical planks extending from the bottom to the surface of the liquor contained therein. These comparatively narrow vertical strips when revolved at about 60 r.p.m., form an efficient agitator for mixing the emulsion and render unnecessary the propellers with their vortex effect described by Kirkpatrick

It will be noticed that tank 13 is always full and that the emulsion has to pass down to the bottom and up the 6-in. connecting pipe in order to reach tank 14 and to avoid any tendency for heavy silver precipitate to accumulate in the bottom of tank 13, the revolving shaft has a pair of long arms or paddles about 3 in. wide, bolted on just above the bottom to keep such heavy particles in suspension, until they can be sucked by the current up the vertical pipe into the next tank 14. This latter tank may be considered chiefly as a pump feeder from which the emulsion passes to the triplex pump 18, and thence to the precipitate press.

CONSTANT LEVEL AUTOMATICALLY MAINTAINED.

In order to maintain a constant level in tank 14 and avoid overflows on the one hand and the entrance of air into the pump suction on the other, a system of automatic control valves operated by a float, is used. It will be seen on examining the sketch that each pump is provided with a bypass, 21 and 24, and both these are operated by a single float shown at 23 in the drawing. The valve 25 which is usually more or less open, is operated by a long lever which is hinged in such a way that it can be bent upwards from the hinge point, but not downwards, and is normally held in a straight line by the weight 26. The vertical rod passes freely through a slot in the lever and carries a tappet in such a position as to engage the lever at a certain height. When it is desired to increase the flow to the precipitate press, the float will rise in the tank until the tappet engages the lever, thus gradually closing the bypass valve 25 and throwing more work onto the pump. The flow may thus be increased until valve 25 is completely closed, this point representing the full capacity of the pump 18. If then, the flow into the tank be further increased the float will continue to rise and the lever will flex at the hinge, thus causing the upper tappet to engage the lever on valve 22 and by opening the same, allow the surplus solution to flow back to tank 1, whence it came. With this device, it is perfectly simple to get any desired flow of solution up to the full capacity of pump 18, maintaining practically the same level in the pump-supply tank. The total time consumed between the point where the precipitant is added and the point where the emulsion enters the press, is from 10 to 15 min. on the average and precipitation is normally complete in this period.

ALUMINUM-DUST FEED REGULATED BY SOLUTION TEST.

The feed of dust is regulated from time to time by taking a sample of the effluent from the press and adding a little strong sodium sulphide solution to it. If the faintest coloration appears (due to the formation of silver sulphide), the feed is increased little by little until the test indicates complete precipitation. The effluent is tested in this way every hour or so and a fine adjustment of the feed is thus obtained.

It has already been stated that caustic alkali is necessary for this reaction, and therefore caustic soda is added to the pulp before cyanide treatment in sufficient quantity to bring the solution up to from 2 to 3 pounds NaOH per ton. In connection with the alkalinity of solutions, there is an important point to be noted. Lime must be reduced to the smallest quantity necessary for slime settlement, because it tends to form with the dissolved aluminum an insoluble calcium aluminate, which collects in the precipitate press, giving a low-grade product and one almost impossible to melt by the usual methods. It is therefore necessary, to ascertain whether the slime will settle readily in a solution high in caustic and low in lime and also whether the use of caustic interferes in any way with the efficiency of the solution for extraction. I may say that neither of these points has so far given any trouble at the Nipissing mill.

PRECIPITATION RESULTS GOOD.

At the time of writing, this process has been in use about four months, so the data available should be fairly reliable. The figures for the first three months of 1913 are here given just as they stand in the official records and include the "bad days" as well as the good ones. These

PRECIPITATION RESULTS.

Month.	Head Assay, oz.	Tail Assay, oz.	Precipitation, %
Jan....	8.23	0.23	97.2
Feb....	8.56	0.21	97.5
Mar....	8.50	0.15	98.2

figures do not represent the full efficiency of which the process is capable, because a few bad assays due to mistakes and oversights, which are unavoidable in stating a new mill, have spoiled the averages. Usually the daily assay stands at about 0.05 oz. silver in the tails and with ordinary care there is no reason why it should ever run over that figure.

CONSUMPTION OF ALUMINUM.

Month	Aluminum, Lb.	Silver Precipitated Oz.	Aluminum Used per oz. of Silver, Lb.
Jan....	2926	141237	0.02
Feb....	2742	143141	0.019
Mar....	3014	142604	0.021

For comparing these figures with those for zinc dust, it is not easy to obtain representative data on the latter owing to the custom of publishing such figures in terms per ton of ore instead of per fine oz. of precious metal. I have, however, come across the following table in the Journal of the Chemical, Metallurgical, and Mining Society of South Africa for December, 1909, which may be of some assistance.

CONSUMPTION OF ZINC DUST PER OZ. BULLION.

Oz. Au+Ag. per ton Solution	Au : Ag Ratio	Lb. Zinc Dust Consumed per oz. Au+Ag Precipitated	Remarks
0.02	2:2	6.60	Homestake low solution
0.15	2.2:1	0.91	Homestake weak solution
0.47	1:4	0.59	Cerro Prieto
0.49	1:4	5.57	Cerro Prieto
0.70	1:4	0.42	Cerro Prieto
1.84	1:19	0.19	Montana, W. J. Sharwood
3.29	1.99	0.16	An American mill

It is impossible to say what the zinc-dust consumption would have been at the Nipissing low-grade mill, because it was never tried there, aluminum having been used from the start. The above table shows, however, that the figure var-

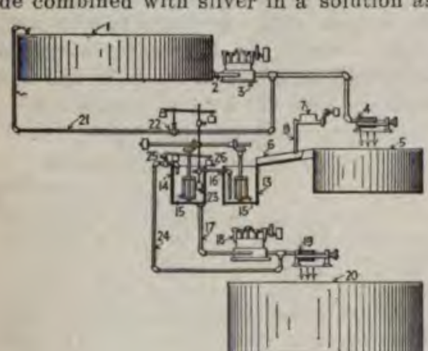
ies enormously with varying conditions and that, as far as the series is carried the higher the metal content of the solution, the less the zinc dust consumption per ounce, so presumably the consumption on Nipissing solution would have been lower than the lowest in the series. On the other hand, the strength of cyanide in the solution, 0.2 per cent, would tend towards a high zinc consumption by direct combination. All things considered a consumption of about 0.1 pound zinc per ounce of silver would probably not be far out as an estimate for comparison with the actual aluminum consumption shown.

REGENERATION OF CYANIDE, AVERAGE OF DAILY TITRATIONS

Month	Titration % KCN Head	Tail
Jan.	0.196	0.228
Fab.	0.181	0.215
Mar.	0.179	0.215

Month	Gain After Precipitation Per Cent.	Per Lb.KCN Per Ton of Solu'n
Jan.	0.032	0.64
Feb.	0.034	0.68
Mar.	0.036	0.72

The regeneration shown above approximates closely the actual amount of cyanide combined with silver in a solution as-



saying 8.5 ounces per ton. It must not be forgotten, moreover, that the cyanide shown to be actually recovered does not represent the total saving effected, because, as already pointed out, there is in the case of zinc precipitation a loss of cyanide by direct reaction with the zinc.

Before we appreciated the deleterious effect on this process of lime in the working solutions, the precipitate presses contained a good deal more calcium aluminate than silver the latter being sometimes as low as 10 per cent. At present the precipitate assays under normal working conditions, between 25,000 and 27,000 ounces per ton, or from 85 per cent to 92 per cent silver. This product may be melted in crucibles without any flux, yielding bullion about 990 fine. At the Nipissing, it is briquetted with a little soda and borax and melted direct in the oil-fired reverberatory already described in the Journal, producing bullion over 997 fine.

The present price of aluminum dust laid down at the Nipissing including freight and duty (15 per cent ad valorem), is from 35 to 39 cents per pound, and of zinc dust 7 cents per pound. Taking the consumption of the two reagents at the figures already given, 0.02 pound per ounce of silver for the first, and 0.1 pound for the second, the ore yielding 20 ounces of silver per ton would show as in table:

COMPARATIVE COST OF ZINC AND AUMINUM METHODS.

Aluminum Dust.

0.4 lb. aluminum at 38c	$0.152
Caustic soda, 1.5 lb. at 2¼c	0.033
Per ton	$0.185

ZINC DUST.

2 lb. at 7c	$0.14
Per ton	$0.14

In the figure for caustic soda, 0.5 pound has been allowed for chemical consumption and 1 pound for mechanical loss.

To offset the extra charge of 4½ cents per ton of ore, there would be a direct recovery of 1.6 pounds of cyanide, at 15 cents or $0.24 per ton; a further saving in cyanide, varying in amount with varying conditions, due to the absence of any action between the precipitant and the cyanide, a saving in the cost of smelting and refining and in some cases, in marketing the bullion. In the case of ores which, on a commercial scale fail to yield the extraction predicted by laboratory work on account of fouling of working solutions, a gain in extraction is obtained which may often amount to 7 per cent, and which in the case of some of the Nipissing ores was as high as 14 per cent.

As an alternative to the use of the dust, Charles Butters, consulting metallurgist for the Nipissing Mining Company, has suggested the use of aluminum granulations placed in a revolving tube mill through which the solution to be precipitated is continuously passed, the attrition produced thereby serving to scour the metal surfaces and thus obviate the principal obstacle encountered by Julian in his experiments.

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Additions of phosphorous up to 1.06 per cent, of manganese up to 1.49 per cent, and of tin up to 1.46 per cent, increase the tenacity and hardness of copper, but decreases its elongation, electrical conductivity and specific gravity. Annealing affects these alloys in a similar way; tenacity and hardness are diminished, elongation is increased, while the density and conductivity are scarcely changed.

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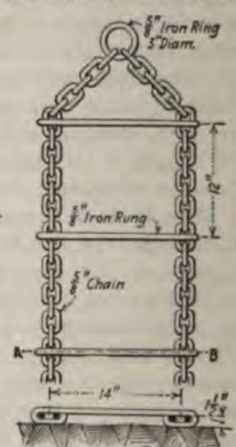
Exports of gold and silver to the Orient from London in 1912 were the largest in 34 years, excepting 1906. In 1906 the movement totaled 14,345,474 pounds sterling, while in 1912 exports amounted to 15,565,334 pounds.

CHAIN LADDER FOR SINKING

The use of iron ladders, especially chain ladders, is necessary in cases where they are exposed to much blasting. They are thus adapted to raising and sinking operations. In sinking particularly, considerations of safety should lead to the providing of a ladderway to the very bottom of the shaft, to afford of exit in case of failure of the hoisting apparatus. This is a precaution often inexcusably neglected. A chain ladder is well suited for use in the shaft bottom, for extending the wooden ladderway. It need be moved only occasionally, the superfluous length being allowed to coil on the shaft bottom, except during firing, when it can be drawn through itself som way up. It can be easily handled in 30-ft. sections.



A method of constructing such a ladder is shown in the illustration. The chains and rungs are both made of ½ or ⅝-in material, and the rungs are spaced about 12 in. vertically and the chains are about 14 in. center to center. The ends of the rung pieces are heated and bent to the proper shape to fit over the links, then reheated and pounded down on the links and hooked around at the ends in their proper position, thus obtaining a snug fit. It is advisable to so hang the ladder that the doubled ends lie against the rock side, which provides a space for the hands, in climbing. The chains at the top can be caught into a 3-in. ring for suspending the ladder.

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The deepest borehole in the world is reported to have been put down in Silesia near Czuchow. The total depth of this hole is given as 2,240 metres (7,347.2 ft.), or a mile and one-fifth. The work cost an average of $10.90 per foot. This is an excessive cost, as at a depth of 4,920 feet it became necessary to enlarge the diameter of the hole.

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The United States standard gold coin contains 900 parts gold, and 100 parts copper.

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CONTENTS: PAGES.

The Wall Street Journal is responsible for the weird story that there is a man in Wall Street, who, for thirty years, has invested or speculated in mining stocks on a system, and has not yet cashed a bet. He bought only the cheapest stocks, paying in no case more than 15c. per share, expecting, of course, that most of them would prove worthless, but hoping that some few might appreciate in value, and make the speculation, as a whole, a winning one. The net result of his operations is that, in the period of thirty years, he has accumulated 1,298,404 shares of 155 different varieties of mining stocks, that the stocks stand him in $125,000, that none of them ever paid a dividend, and that there is now a bid price for only four of the 155 varieties. His holdings of these four he could sell for approximately $250.—Engineering and Mining Journal.

He also could have loaded up on "Comstocks" at many dollars per share years and years ago and witnessed their decline to nothing—with regular assessments added, and still being called for —while, within the past few years he could have secured reams of the highest-priced wall paper in the world and have seen it degenerate into the poorest kind of wrapping paper.

TIPSTERS AND TIPPEES IN THE MINING BUSINESS

One of the most pernicious and insidious practices ever evolved for the furtherance of selfish, dishonest gain and prominence in the business of mining is that of "tipping." The definition of the word and the field of operation it covers is only feebly comprehended by dictionary editors and its baleful influence is so far-reaching that to even imperfectly conceive what it amounts to must necessarily involve years of active life in the atmosphere which it permeates and a clear sense of the object sought in the employment of the art—for it is an art of the most subtle kind.

The tipster in the mining business is not to be confounded at all with the social tipster; nor is the tippee to be confounded with the fawning, servile being who accepts the quarter, half-dollar or other small sum for the closer attention or better service he is expected to (or does) render the tipster—not at all. The tippee in mining is a diverse entity —perchance genderless and maybe characterless—whose influence, once brought under subjection by the tipster, is wielded as a bludgeon or shield (as occasion demands) in destroying opposition to or warding off public criticism and comment upon, schemes being worked to fleece the public. The tipster in mining is usually a broad-visioned fellow and a good judge of human nature; he is jovial, suave and companionable and when his snare enmeshes the tippee whose influence and support he has been working for it feels so comfortable that the ensnared scarcely realizes the discomfort that must follow the inevitable awakening to the fact that he has been "bought" and MUST, thereafter, play the game without protest.

Who are the victims of the mining tipster? Their name is legion. The tippees—as illustrating the classes about which this article is written—are those who are more or less unconsciously made to serve the purpose of the tipster in luring "investors" and "speculators" to their doom. The real victims are the purchasers of the inflated, watered, boosted, boasted and bolstered stocks of corporations, the promoters of which expect to make their REAL MONEY through the distribution of shares and the manipulation of both mines and markets. The investing and speculative public has been educated to believe that most of the crooked business in mining exists only among promoters of what are popularly termed "wild-cat" propositions and this confiding belief is what has made it so much easier for the "wolves in sheep clothing" in the "legitimate" field of mining to command a prestige and following which they do not deserve.

The common "wild-cat" promoter secures the majority of his victims through depicting in glowing terms the successes of others. His methods are largely tinsel and show—blase and crude. He captures the ignorant and unthinking classes—those who readily are made to believe that gold grows on trees—that it is easy to get returns of $1000 for $1. The "wild-cat" promoter also works the tipping system as best he can, but he never becomes a graduate of the scientific class that makes it yield millions—that reduces the business to an art—and he never reaches the class that worship at the shrines of the real masters of the game. It is only during wild boom periods that the "wild-catter" gets past the "penny ante" stage of mining the public and the real, legitimate investors and stock speculators would not listen to him for a minute; they prefer to be soaked right and soaked hard—through their best friends, perchance—so that they will have something to remember; even though they are never able to quite understand why and how they came to be bumped.

In "high finance" mining the tipster employs the most subtle methods. He first of all reaches out and cultivates the friendship and good will of the newspapers, particularly those published in the region of his company's contemplated operations. Does he buy advertising space in the paper? Does he attempt to buy the editors and thus dictate the policy of the publication toward his "enterprise?" Be certain that

he dces nothing of the kind. He knows, to begin with, that the paper at least poses as a friend and booster of the community in which it exists; that he must not attempt to control its policy as far as it relates to treating kindly any new and "tremendously important" enterprise that is being launched, and so, after the first announcements are made in big type and the paper has painted the finest picture it can, the tipster usually affects a shyness for publicity; he prefers to let the undertaking "speak for itself," etc., so that when information is released the reporter and the paper's management may properly appreciate his condescension in submitting to interview.

As the "enterprise" is rounded into form and the time approaches for properly impressing the public with the magnitude and worth of the proposition from an investment standpoint, the tipster begins to play his hand. He eventually tells the reporter how much he appreciates the way he treated the information he had released from time to time, and probably says something like this:

"Now, to show my appreciation of the way you have treated me—and assuring you that this invloves no future obligation on your part—I am setting aside a small block of the stock in this company to be sold to you at the present price whenever you see fit to exercise this option. The stock is worth a great deal more than it is now selling for and I sincerely hope and believe that within six months (or any time agreed upon) you will be able to reap a handsome profit. You see I am not giving you anything; I am simply carrying this stock at the price I buy it for today so that you may reimburse me when the right time comes and make whatever profit there may be in the transaction. To give you the stock might be construed as bribery and I am not in the bribing business; it is not necessary to the success of our enterprise that we do anything that is not absolutely legitimate in business; but you know that already. I feel obligated to you for the way you have treated me in the past and this little turn, which costs me nothing, is intended simply as a slight recognition of my appreciation. Please say nothing more about it."

From the minute that reporter left the office of the tipster he became the willing, or unwilling (possibly) slave of that tipster, did he not? While the tipster gave him to understand in no uncertain manner that no obligation attached to that transaction, both were conscious of the fact that a relationship had been established that would allow, on the one side, supplying of any kind of "boost" information to that reporter's paper in the future with a certainty that it would be used—and on the other, no chance to escape. The reporter knew he was "landed," so the only thing to do was to boost as hard as he could and make as much as possible out of his stock option. That reporter had not been bought, in the accepted definition of the word, but he was a tippee, just the same, and placed, so far as that particular proposition was concerned, "hors de combat."

But the work of this tipster has only just begun. This is no ordinary undertaking. It involves the expendieure of millions of other people's money in rounding it out and, before the stock can be unloaded at soaring prices, bonds must be sold. The papers must help—and they do help. Maybe the proprietors are directly—or through the tipped reporter—advised that these bonds are to be made convertible into company stock at a certain price after a certain time. As little of the stock has yet found its way into the hands of the public it costs nothing to move the price up. The newspaper owner or publisher understands this and he buys a block of the stock on margin. As soon as the conversion mark is reached he sells out, make HIS profit, and also becomes a tippee. His paper, then, is a bought booster for the game and it has no chance to escape and indulge in any crticism of Mr. Tipster's "world-beating" (and the word beating is used advisedly) enterprise.

With the foregoing illustrations ot how the mining promotion game is played, in both high and low degree, is not the reader able to comprehend, or understand, at least some of the reasons of why a number of noteworthy propositions have been apparently successful during the past few years?

Does this recital not bring to view a glimpse of the schemes that have been perpetrated in many of the big copper and other flotations which have been monopolizing public attention so long? And does it not suggest that most of the public utterances concerning them need careful weighing before credence is allowed?

Going back over the history of Utah Copper, Ray Consolidated, Chino Copper, Braden, Yukon Gold, Butte & Superior, Alaska Gold Mines, etc., it should not be hard for those who have been following the course of events to appreciate why the daily press has been made subservient to the wishes and the demands of the promoters, and why it has been simply impossible to get disinterested and truthful information concerning the REAL MERITS AND WORTH of any of them. If the newspapers of the country which specialize in mining information have become corrupted and their utterances are no longer to be trusted, what must be expected from sheets controlled by brokerage houses, the modern mining "MARKET LETTERS," etc.? If the tipster is able to control the public press along lines indicated by this review of conditions, why should a prospective investor, or a speculator, expect anything but loss if he relies for tips on market letter information.

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SEEKING PASTURES NEW

When a fisherman finds that a stream has been "whipped" too hard and that the fish are shy and scarce, he breaks camp and goes somewhere else; when the stockman finds his herds have cleaned up one range he moves on to another—he seeks new pastures. By the same tokens it stands to reason that when mining promoters find "thin picking" in an overdone section of the financial, speculative and investment world they, too, will seek a less-worn field in which to operate. These and kindred reasons are presented by those learned in the art of successful prognostication as accounting for the reported determination of the promoters of the Alaska Gold Mines scheme to establish headquarters in San Francisco of the "vice-president, in charge of operations."

According to a recent arrival from San Francisco the tip has already been passed to the "inner financial circle" of the coast metropolis that the low-grade porphyry, gold and zinc crowd is going to show the natives how little they know—or ever have known—about the gold mining game. The coast financiers and the coast investors and gold miners are going to be given free kindergarten instruction in the art of mining, milling and smelting Alaska gold ores for seventy-five cents a ton or less. As a result of this education it is promised (so our San Francisco informant claims) that the coast investors will fall over each other in their frantic efforts to play the game. As the west-coasters have never taken to the low-grade porphyry copper mining business on account of their preference for gold mining, it is figured that they know nothing of the deceptive methods that have been practiced in the eastern and foreign markets to fleece the public.

But our San Francisco friend assures us at the same time, that those who are accredited with the preparation of this

move on San Francisco, are destined to brush up against the "real thing" when they undertake an invasion of the jealously guarded preserves of the coast money kings; that they will encounter a combination of princely entertainers who will "go them one better" in any move they make and see to it, at the same time, that their own money stays at home; while any contributions that the invaders feel disposed to make will be as graciously received as was F. Augustus Heinze's "wad" when he undertook to show the easterners how to do a banking business.

From this point the play of the "invaders" will be watched with keen interest, and particularly by those who, through their "investment" losses, have been unwilling contributors to the invasion "jack-pot."

FIGHTING THE SMELTER TRUST

Apparently Sidney Norman who, as a minority stockholder in the Federal Mining and Smelting Company, is conducting the suit for the abrogation of the robbing smelting contract with the American Smelting & Refining Company, seems determined to carry the fight as far into the ranks of the enemy as possible. His latest move was to send a letter to the president of the United States through Senator Poindexter in which he called attention to the activities of the Smelter Trust in the matter of revision of the tariff on lead. About the first of the month the dispatches told of the letter having been submitted, but only a slight inkling of the contents of the document was given by the papers. Knowing that western mining interests would be deeply interested in the subject a copy of Mr. Norman's letter was sent for. It reads as follows:

"I have read with great interest your protest against the insidious efforts of the lobbies maintained by special interests at Washington to further their efforts to confuse the public mind in the matter of tariff revision and take your announcement as an invitation for all citizens to strengthen your hands by giving publicity to specific instances of such tactics

"I am a plaintiff, with other minority stockholders of Federal Mining & Smelting Co., in a suit which has been brought in the Supreme Court of New York against the American Smelting & Refining Co. and the Guggenheim interests, in which we allege fraud in the execution of a certain contract between the American Smelting & Refining Co. and the Federal Mining & Smelting Co., both of which corporations are controlled by the Guggenheims. In the preparation of this suit I have had occasion to investigate the metal schedule in its bearing upon lead and have also received some interesting information concerning the methods used by the Guggenheims and their so-called "smelting trust" to distort the real position of affairs in the hope that Congress could be induced to retain the present level of protection upon lead in ores and in bullion.

"Early last year the secretary of the Federal company was instructed to send a circular letter to each stockholder calling attention to the probability of revision of the metal schedule under Democratic administration, predicting dire disaster to their investment (already nearly wiped out by the dishonest methods of the trust) and asking each stockholder to use every possible pressure upon the congressional delegation from his particular district to secure retention of the present protective tariff on lead.

"About the same time holders of preferred stock—a 7% cumulative issue of $12,000,000 in $100 shares -were notified that their dividend rate would be reduced to 6%, in spite of the fact that the company's treasury contained ample surplus for full dividend purposes and that the current earnings were more than sufficient to provide the difference. Stockholders who protested against this reduction were informed by a prominent official that the decrease was but temporary and was in the nature of a manufactured argument in favor of retention of the present lead tariff to be used before the Ways and Means committee of the House of Representatives.

"The principal arguments against the reduction were presented by the Coeur d'Alene Mine Owners' Association and a similar organization of Utah. The tariff activities of both of these organizations have been directed and controlled, either directly or indirectly, by the Guggenheims and their smelting corporations. Representatives of these organizations appeared before the Ways and Means committee in fact, though not in name, as the lobbyists of the smelting trust, stating orally and in briefs that the mines of the Coeur d'Alene district received for their product during the years 1909-10-11 the full New York market price of an average of $4.401 per hundred pounds of lead, when, as a matter of fact, they received but $3.84 per hundred pounds. These lobbyists also threatened a decrease in miners' wages or total cessation of work in event of a material reduction of the lead schedule. Through its control of the Federal Mining & Smelting Co., from which it exacts an illegal tax of from $600,000 to $1,000,000 a year through a fraudulent contract that runs for twenty-one years, the trust controls practically 50% of the entire output of the Coeur d'Alene district. Other smelting contracts covering mines which they do not control give the Guggenheims monopoly of practically 75% of all the lead derived from the district. In Utah similar conditions exist, although I am not at this time able to quote exact figures.

"Analysis of the briefs now on file and perusal of smelting contracts then in effect with the trust will prove that my assertions are correct and that the trust during the three years covered by the briefs absorbed in initial charges no less than 37% of the total protective tariff paid by the nation for encouragement of the actual producer. Investigation of local conditions will also conclusively prove that the balance of such protective tariff was more than completely absorbed by a wholesale manipulation of shipments which exacted long-haul rates from the producer and delivered his product at a short-haul point.

"Prominent among those who have represented the trust at Washington during the present agitation is Harry L. Day of Wallace, Idaho, president and general manager of the Federal Mining & S. Co. by virtue of control of that corporation by the trust, who draws a salary of $15,000 a year from the pockets of stockholders ostensibly to protect their interests, but in reality to further the machinations of his real employers, the Guggenheims. Mr. Day is also part owner of the Hercules mine in the same district which now ships its product to the trust under a more favorable contract than is granted to other producers.

"I bring these facts to your attention in the hope that knowledge of them will aid you to fortify yourself against the efforts of the smelting trust, which has until last March, maintained its own personal lobby in the Senate chamber in the person of Mr. Simon Guggenheim and which now seeks to bulldoze and mislead you through its agents. Any expert upon the condition of the lead industry will be able to prove to you that the world's production is now short of consumption that this country has probably reached its productive zenith and that, within a very few years, the United States must become a buyer instead of a seller in the world's markets. Such an expert could also give you some interesting data as to the reason for the present low quotation on lead, which has fallen nearly 75c. per hundred pounds since last November in the face of a normal business demand.

"My position as the owner of stock in a lead-producing corporation and a supporter of your tariff plans may be considered anomalous by many others similarly situated, but it is evident to me that the tariff question will never be settled for the best interests of all the people until immediate personal profit is in measure forgotten. Personally I am of the opinion that it is both absurd and iniquitous to further fatten the smelting trust of the Guggenheim brothers by taxation of the nation at large. I almost believe that in the long run the nation would experience less loss by closing every lead mine in the country for a period of years, if by so doing it could be rid of a ruthless, blood-sucking organization, without honesty or knowledge of square-dealing, which now constitutes a tremendous menace to the whole mining industry and particularly to the small producer."

STIRS UP NEW YORK EXCHANGE

Following is a copy of a letter addressed by Sidney Norman to the President and Board of Governors of the New York Stock Exchange, on the 17th of the present month:

I acknowledge receipt of your communication of the 13th inst. in which you violate all the rules of justice and fair play in denying me copy of alleged "satisfactory evidence" upon which you base the opinion that the American Smelters Securities Co. did not control Federal Mining & Smelting Co. when the former was listed on your exchange in October, 1909.

Such opinion naturally means that you have elected to ignore the stock books and other records of the company and in their place accept the unsworn, unsupported word of the very official accused of the original deception. It also implies your belief that the affidavit filed by me cannot be substantiated. My reply to you is that every allegation therein will be fully proven at the proper time before an impartial tribunal, thus also establishing the fact that the New York Stock Exchange will go to any lengths to protect those who are financially powerful and that it cares nothing for the public losses made partially possible and in some cases criminally easy by the lax methods of its own committees.

There is another feature of this matter which you have possibly overlooked. If Mr. Brush's secret statements are to be given credence it naturally also means that the public advertisement of M. Guggenheim's sons in in the New York Times of Dec. 21, 1911, was a deliberate lie specifically published for the purpose of misleading the public by further concealing control of Federal. Consequently, if I am well advised, either these statements or the advertisement constitutes a misdemeanor under the New York criminal statutes.

The matter will by no means be allowed to rest where it is and you will yet be given an opportunity of showing the public what you consider "satisfactory evidence" in such cases. Meanwhile the reason for the unfortunate position occupied by your organization in the eyes of the public will be better understood and 2,000 stockholders of Federal, including 700 women dupes, will rightfully conclude that it is idle to expect you to take any action calculated to protect those who have been robbed under the threadbare cloak of a supposed respectability accompanying official listing of a security on the New York Stock Exchange.

I regret that you have seen fit to ignore the plain rules of justice, but confess it was nothing more or less than was expected by me or by those associated with me. I am leaving in a few days for a month's trip to the West and trust that I shall not again be treated with the unfairness which characterized your conduct in this matter during my previous absence from the city.

ANSWERS TO CORRESPONDENTS

Mines and Methods receives a great many inquiries concerning mining propositions and requests for advice or enlightenment on various matters during each month. Some of these require personal replies, while others might just as well—and with all propriety—be made public. Therefore, readers of this publication who ask questions and seek information that can just as well be handled in this department, will find their answers here.—Editor.

New York, May 29.

I have just been going through the handsomely printed annual report of the Utah Copper Company. In the large photographic presentation of the steam shovel workings above the deep hole in the foreground it looks to me as though some of the numerous grades or banks on which steam-shoveling has been done were caved and that these grades or levels had been restored by the help of brush or pen or in "retouching" the negative. Do you believe that such is the case, and if so, why was it done?

E. M. J.

Mines and Methods has repeatedly told of the loss of steam-shovel benches by caving of the precipitous mountain side and the wrecking of steam shovels. A picture that did not cover up such palpable marks of managerial folly would have no place in an annual report designed to impress the shareholders and the public with the belief that criticism of this method of mining at the property was vicious and unjustifiable.

* * * *

Boston, June 3.

It was a great surprise to me to learn through your publication that D. C. Jackling was retiring as general manager of the companies with which he has been so prominently identified. Your criticisms of his policies and abilities I have always felt sure would eventually be shown as unworthy, unjust and uncalled for; now I don't know what to think. Did he retire voluntarily, or was he asked to resign? Wm. McA.

We dislike to encroach upon the legitimate prerogatives of others and would therefore suggest that our Boston correspondent fire his query to the Boston News Bureau, or the Boston Commercial, either one of which we are sure—while they have studiously avoided saying a word about it—can tell precisely why the candle snuffer was dropped over the spot light in which Mr. Jackling's brilliancy has been intensified so long If neither of these publications are footfree enough to tell you call on us again and we shall be pleased to advise you.

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Salt Lake June 14.

According to one of the local daily papers Hayden, Stone & Co., in their notification to Alaska Gold Mines stock subscribers that the second payment of $5 a share will be due July 1, state that on the surrender of receipts for the first $5 paid and a check for the other five, "elaborately engraved stock certificates" will be issued. What do you suppose was the object in referring to the certificates as being "elaborately engraved?" —Subscriber.

Our idea is that the intention was to impress on the subscriber the fact that it was not the purpose to take his $10 without giving ANYTHING of value in return.

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New York, June 16.

The word is being passed along here that a tremendously rich strike has been made in the Alaska Gold Mines Company's property. It is said that sixty feet of $4 ore is being rapidly developed and that the news is being reserved for release upon the return of Vice-President Jackling who is now said to be on his way to the property. Do you think we are getting the right tip? —E. E. & Co.

That such a report may be released upon the return of Mr. Jackling we have no reason to question. Alaska Gold is being touted by insiders as "the best thing we ever had"—and maybe it is, but that would not be much of a recommendation for it as an investment. And if you think you can speculate in it and get away without burning your fingers, just try it. "Startling disclosures" ought to be made with systematic regularity at the Alaska Gold mines from now on and the original 50,000,000 tons of $1.50 ore ought easily to expand to 200,000,000 tons of $3 ore within a year and to 600 000,000 tons of $5 ore within two or three years. It will have to do that well if it outshines the records of the low-grade porphyries promoted by the same community of interests—and we understand the mountains back of Juneau are large enough to supply a limitless tonnage of rock more or less valueless.

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In its review of April operations at the Utah Copper Company's property the Boston Financial News had this illuminating comment to make: "Some rather significant results have recently been obtained in the retreatment of the low-grade concentrates by a flotation process based on that in operation at the Butte & Superior. In case further experiments prove satisfactory, the management believes that by means of this process it will be possible to affect a saving of from $250,000 to $500,000 annually in smelting charges." The Utah company's troubles in this respect were fully ventilated in last month's issue of Mines and Methods; previous to that time there was nothing in the published reports of the Utah company to create the slightest suspicion on the part of the public that there was anything wrong with the grade of concentrates produced at the company's "most perfect" milling plants. But the company's milling troubles are not the only ones, as was clearly shown last month. The property holdings of the company are running mighty short of the kind of ores that will produce a profitable concentrate under the long-term contract entered into with the Guggenheims and, while it is commendable that the present management should seek a means of doing better mill work, it is certain that the original blunder of falling into the smelting contract trap can not be counteracted through anything but a repudiation of that contract, and whilst the Guggenheims are the heaviest holders of Utah Copper shares, and in full control, it is not to be expected that they will relinquish the stranglehold which their smelting contract gives them over the much greater, but scattering, interests in the Utah Copper Company.

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A news item from New York early in the month stated that the $15,000,000 convertible bond issue of the Guggenheims' Chile Copper Company had been "privately subscribed." In other words, the public declined to bite. Verily, the name of Guggenheim has lost its magic.

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It is said that Mr. D. C. Jackling is to go on the board of the General Petroleum Company; presumably Hayden, Stone & Company have been enlisted in the campaign for financing this rapidly growing newcomer among California oil companies.—Mining and Scientific Press, June 21.

How the mighty have fallen.

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The mineral nemalite is a fibrous variety of bucite, a hydrate of magnesium. It is translucent and occurs in slender fibres, which are elastic and easily separated. Its color is white, with a tinge of yellow. It has a silky lustre.

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If diamond-drill rods are greased with melted tallow or other suitable lubricant and then coated with Stockholm tar, it will be found that the tar will make a smooth lining in the hole which tends to prevent caving, says W. H. Trewartha-James (Bull. No. 95, I. M. M.). In some cases, particularly where there is sulphur in the strata, the casing thus formed is almost as hard as cement.

Formation And Growth Of Disseminated Copper Deposits (II)

By JAMES O. CLIFFORD.

In considering the structural relations of the rock series of a disseminated low-grade copper deposit it is pertinent to observe, as outlined in a previous paper, that two conditions are primarily essential; that is, the original mineralization generally is coextensive with areas of igneous intrusive rocks, or the metamorphic derivatives thereof, and that in order to afford an opportunity for the processes of enrichment to be carried out the mineralized area must necessarily be exposed to weathering agencies. Whether we consider a condition of absolute localization or of uniform dissemination of the original ore deposition matters little, as the ultimate result in the matter of secondary mineralization by enrichment will be the same, or nearly so. Thus, if we assume the original mineralization to have resulted in the formation of localized ore deposits of copper as replacements in the overlying sediments, as contact-metamorphic deposits, or as fissures—a condition which naturally would occasion an impoverishment of the mineral content of the magmatic mass as a whole—or whether the intrusive mineral-bearing mass retained its content as a uniform dissemination of original ore, the ultimate result in the matter of secondary enrichment would return the same result. This condition perhaps is best illustrated from the fact that the quantity of mineral carried to the surface by the magma would be definite, and the question then would be one merely of the mode of distribution at the time of original mineralization, dependent, of course, upon the physical and chemical conditions obtaining during the period of intrusion relatively to the rock composition.

GENERAL STRUCTURAL RELATIONS

The general structure of the so-called porphyries seems to follow a well-defined line in that they represent a condition wherein the over-lying rock series (generally sedimentaries) were domed up through the intrusion of acid or basic igneous rocks, resulting in the mineralization of the rock mass either as localized or disseminated ore-bodies, or as a composite of both. Types of both completely localized and of thoroughly diseminated deposits are common throughout the world, and it is not infrequent that they show evidence of the composite condition. However, in view of the circumstances surrounding the period of original mineralization as evidenced in numerous cases, the general condition seems to have been a localization of ore deposits with fractional dissemination, rather than the converse. This is true particularly where remnants of the overlying sediments containing ore deposits of the replacement type have been partially preserved, plainly evidencing a condition of impoverishment of the underlying intrusive responsible for the mineralization.

In many instances, due to the absence of the complete rock series, the assumption naturally obtains that the original mineralization represents a complete dissemination of mineral through the agency of the igneous rock, whereas, in fact, such a condition did not exist, but through later adjustment of the igneous rock affording channels for the percolating solutions, enrichment was brought about in a manner simulating complete dissemination.

For this reason it seems inadvisable to consider the "porphyries" under a common classification as disseminated deposits because the factor of original deposition should take precedence rather than subsequent, or secondary mineralization. It would seem that, under the circumstances, there is no direct law of rock classification, and while selective association (in which each mineral prefers or tends to occur in certain rocks rather than in others) is now a thoroughly recognized law, the more plausible view seems to be that the metal follows its own law of segregation rather than that of the rock segregation. It follows, therefore, that the occurrence of copper mineral as a dissemination in monzonites and quartz porphyries is directly not a criterion governing its absolute genesis, but rather a condition obtaining due entirely to the position of the rock series in any particular deposit relatively to the original mineralization of the superincumbent areas.

In any event, and considering the theory as advanced at present, the essential conditions necessary to the formation of zones of secondary enrichment as a disseminated deposit are strong faults and minute fracturing of the intrusive igneous rock across all horizons, resulting in the formation of zones of complete brecciation. The occurrence of large and well-defined fissures plays a very important role as evidenced in the formation of zones of secondary enrichment in unusual development. These conditions may have occurred at the time of original mineralization, or at a later period through adjustment of the rock mass, but in either event the ultimate result, insofar as enrichment is concerned, will be the same.

LOCALIZATION OF ENRICHMENT.

Synclinal folds play a most important part in connection with downward enrichment of disseminated ore deposits relatively to the condition of mineralization wherein the anticlinal fold represents the original deposition, inasmuch as the side of the basin problem considers the transportation of minerals in solution from the upper area to a lower horizon. For example, we may consider a condition very common among the porphyries wherein the sedimentaries were domed up by a granodiorite intrusion resulting in mineralization, as hereinbefore mentioned. Then through subsequent degradation of the upper exposed area its contained mineral was subjected to weathering resulting in complete oxidation and transportation (in solution) to a lower horizon, the process being continued till the original intrusive rock was itself exposed and subjected to the same treatment. Dependent upon the extent of faulting, fissuring and brecciation of the rock mass, enrichment would follow the line of least resistance.

In the absence of strong faults and strong fissures, but under a condition of complete minute fracturing, the natural result of enrichment would be the confinement of the descending solutions in part to a definite area resulting in the formation of a uniformly disseminated deposit. On the other hand, in the presence of faults and fissures, the natural tendency of the downward percolating solutions would be to concentrate therein and form localized bodies of secondary enrichment. However, under favorable conditions the drainage lines of the ridge exert considerable influence upon the descending solutions relatively to the respective slopes thereof. Assuming no outlet of magnitude intervening between the top of

the ridge and the two bounding valleys it is pertinent to consider the condition of a concentration of solutions underneath the main drainage line of the basins rather than on the side of the basin; provided, of course, that the topography is sufficiently mature and has had time to permit the concentration of solutions under the central drainage lines, and further, that the copper solutions down the axis of the valley have not been diluted to the point that they will not precipitate in quantities sufficient to produce commercial orebodies.

TOPOGRAPHIC AND CLIMATIC CONDITIONS.

Topographic and climatic conditions are very important factors in the development of a commercially valuable disseminated copper deposit. Extreme youth of an area representative of original mineralization, when accompanied by intensive erosion of the surface, results in a very slow enrichment due to the fact that the necessary processes are not allowed to be completed before the material is removed; consequently, if enrichment is at all evident generally it is confined to the upper horizons and is merely superficial. Ordinary youthful topography, assisted by reasonably vigorous erosion of the surface, affords a better condition, while a thoroughly matured topography results in enrichment under the drainage lines. Influencing factors are changes in topography and general structure of the rock mass through subsequent regional earth movements, and it may happen that after a partial completion of enrichment over a given area that there has been a change which will afford either better or worse conditions relatively thereto.

An essential condition seems to be considerable variation in climate over long intervals of time. Semi-arid to arid climates afford satisfactory conditions under certain circumstances. Wide variation of temperature and sufficient moisture accompanied by relatively high temperatures accelerate decomposition of the exposed surface. In this connection it is pertinent to observe that these conditions are the more nearly met in the semi-arid or arid regions than elsewhere, chiefly at altitudes ranging from 4,000 feet and upward above sea level.

PHYSICAL AND CHEMICAL CONDITIONS.

Rock composition generally is the controlling factor governing secondary sulphide enrichment. Dependent upon the power of resistance to physical disintegration orebodies will be formed relatively to the structural conditions surrounding the rock mass. If the intrusive igneous rock, or its metamorphic derivatives, present a compact, unyielding mass not readily amenable to the weathering agencies, it is not likely that enrichment will extend to any great depth; in fact, there will be little or no change in the original mineralization as represented therein. On the other hand, where the rock mass presents a physical structure susceptible to disintegration through weathering processes the condition then is conducive to the formation of secondary sulphide deposits. This is best illustrated, perhaps, by the fact that, where the composition of a rock mass of original mineralization is such that it is subjected to physical disintegration and chemical alteration by exposure to weathering agencies, the exposed portion containing original minerals will be thoroughly oxidized and the copper mineral content thereof in part carried to a lower horizon as an enrichment product, leaving a leached zone of barren capping on the surface proportionate to the intensity of oxidation.

Where conditions are favorable, and the original mineralization carried a relatively high iron pyrite content, it is not unusual to note outcrops of leached areas of capping, or barren rock, composed chiefly of impure hematite representative of the superficial alteration of the exposed surface of the mineral deposit. Generally the more hematite the capping shows, the more iron sulphide will be found in the fresh ore at a lower horizon. Often the residual products of pyrite oxidation are carried by surface waters into adjoining porous rocks impregnating them to the extent that they simulate the original leached area. It follows, therefore, that the apparent area of superficial alteration represented by the iron capping does not indicate the existence thereunder of an enriched zone, only as referred to the original copper mineral content of the mass relatively to the structural conditions obtaining.

Altered areas represented by iron capping do not invariably indicate zones of copper sulphide enrichment, nor is it necessary that there be present any iron capping whatever, as many large deposits show merely inconspicuous outcrops of rotted rock. Finally the principal conditions necessary are the mineralization of the original rock mass; the physical structure thereof; topographic and climatic conditions favorable to the complete degradation and transportation by progressive action of the copper minerals in solution to a lower horizon, there to be precipitated either upon leaner pyrite in the formation of workable bodies of secondary sulphide enrichment, or else, in the absence of primary pyrite, as secondary carbonates and silicates.

GENERAL CHEMICAL PROCESS.

The oxidation of a deposit of sulphide ores is practically the same regardless of the form or character of the deposit. The solution of the sulphides generally is in the nature of sulphates, resulting in the precipitation of the metals at a lower horizon in the form of secondary sulphides. The reduction of the sulphates to metallic sulphides may be accomplished by several different processes, but most frequently by carbonaceous matter, precipitation by hydrogen sulphide, or the reaction of the metallic salts with the unoxidized sulphides below water level; in which event the latter go into solution as sulphates (or other salts), the former precipitating as sulphides.

The first reaction considers that of the oxidation of the original sulphides. Aside from the exposure thereof to the action of atmospheric oxygen and moisture, strong oxidizing agents, such as ferric salts, play an important role. Relative resistance to oxidation and solution is an important contributing factor, and it may happen that chemical action is slower than the physical in which event the partially decomposed original product might be carried away before its contained copper content has been thoroughly leached and carried downward. Further, the chemical and physical composition of the gangue minerals may be such as to make them exclusively the determining factors.

IRON SULPHIDE A FACTOR.

Where pyrite is the predominating sulphide of the original mineralization its products of oxidation are particularly essential as reagents in the enrichment process. There are several ways by which reduction of the pyrite to ferrous sulphate is accomplished: (a), by oxidation solely by atmospheric oxygen, resulting in the formation of ferrous sulphate and free sulphur; (b), reduction to ferrous sulphate, and formation of sulphur dioxide, and (c), a more complete reduction by combined free oxygen and water to the ferrous sulphate and sulphuric acid. In the presence of an excess of sulphuric acid the ferrous sulphate, assisted by free oxygen, results in a further reduction to ferric sulphate. Ferric sulphate, however, is unstable near the surface, but at lower horizons (and assisted by other ferric salts) becomes an active oxidizing solution. Consequently the instability of ferric sulphate near the surface, and the active evaporation attending its presence, results in its forming a product consisting of the various hydrated

oxides of iron. The oxidizing action of ferric sulphate at lower horizons in the presence of water results in its breaking up into two molecules of ferrous sulphate, one of sulphuric acid, and a free atom of oxygen to attack oxidizable substances.

Considering the chemical changes that would take place when copper sulphate comes into contact with iron sulphide, the copper sulphate is reduced to cupric sulphide with the formation of ferric sulphate and the liberation of free sulphur, the ferric sulphate would in turn easily be reduced by hydrogen sulphide or free sulphur. The presence of hydrogen sulphide, resulting from the attack of free sulphuric acid on pyrite would result in the formation of the cuprous sulphide. However, in the direct formation of cuprous sulphide from an assumed solution of copper sulphate it probably would be more reasonable to consider the reactions as obtaining only between copper sulphate, iron sulphide and water; in which event a direct reduction to cuprous sulphide would be brought about with the formation of ferrous sulphate and sulphuric acid with no liberation of free sulphur. The exact chemical reactions governing secondary enrichment will never be written, but some light may be shed on the subject by means of the results obtained in laboratory experiments.

Little attention nas been given the subject of tne important influence of sphalerite as an active mineral constituent in the chemical reactions governing sulphide enrichment. That it plays a very important role in the case of many of the "porphyries" is well known, but investigations have not been sufficiently thorough to afford much data on the subject.

While thus far we have considered only the relative reactions between metallic sulphides, if we assume the solutions of the original leached area to have been copper bicarbonate instead of copper sulphate results will be obtained wherein the iron will form as a carbonate in lieu of sulphate. However, if the downward percolating solutions carrying copper carbonate do not encounter sulphide precipitants they will not form sulphide deposits at any depth. In consideration of this it will readily be appreciated that the chemical reactions governing the process may be acid, basic, or neutral and as there is no fixed rule in connection with the formation of downward sulphide enrichment deposits other than that above outlined each individual deposit must be considered independently.

Sand Filling As Support Of Mine Workings

By Al H. MARTIN.

The extraction of pillars of rich ore, and permanent support of the old workings, has been a problem for most mine managers from the days of comprehensive lode mining. The most general practice has been the close timbering of heavy ground with expensive timbers, but this has prevented in most instances the subsequent mining of portions of the ground, and compelled the management to abandon numerous pillars of rich quartz, as the timbers have needed the support of the column of rock to sustain the tremendous weight of the hanging-wall. Not only has the adequate support of the underground workings compelled the constant attention of the manager during the active life of the property, but even after the passing of its productive period, because of surface disturbances. The subsidence of the old mine workings has often endangered portions of towns and cities, and legislation has been frequently threatened against the mine owners to prevent trouble of this character.

The finest grade of timber is certain to weaken and collapse under the crushing strain of millions of tons of settling earth in the course of years even when supporting pillars are permitted to carry the greater portion of the strain. In many of the Rand mines, and numercus American properties, it has been found that the ore pillars show decided signs of crushing after carrying the prodigious weight for some years, even with the reinforcement of close sets of timbers. This is particularly marked when the vein-system has a fairly steep dip. Various expedients have been proposed to overcome the problem, and in several instances efforts have been made at its solution by employment of steel timbers, and reinforced concrete supports. Objections to such practices have developed, but the method has generally proved satisfactory when compared with old-time provisions.

It has fittingly remained for the great Rand mining field of the Transvaal to devise and perfect a method at once satisfactory and inexpensive—a method that has so convincingly demonstrated its merit that its use is becoming general throughout the greatest gold field of the world. On the Rand mining is conducted on a stupendous scale hardly appreciated in other fields, and the question of adequately supporting the mine workings at low costs has developed into a vital consideration. Practically all the premier companies have devoted special attention to the subject and after years of systematical experiments sand-filling has been selected as the ideal solution of the vexing question. The employment of the method has been particularly marked during the past two years, and its use is making rapid advances throughout the entire field. The success of the experiment on the Rand has claimed some attention from American operators, but is deserving of a better reception than has been generally extended it on this side of the hemisphere. American mine managers are proverbially slow to adopt the practices developed in foreign fields, which may account for the apparent indifference accorded the method developed by the Transvaal operators.

One of the most successful of the sand-filling plants on the Rand is that operated by the Witwatersrand Deep, Ltd., which has been in commission about eight months. The plant was designed after the method had been thoroughly tried out by several other operators, and embodies all the good features of earlier installations, together with many original improvements of merit. The mill of this company crushes about 38,000 tons of ore per month and 60 per cent of the reduced product is sand, or approximately 22 000 tons. All of this is turned back into the mine for filling of the old stopes and other workings. The Witwatersrand Deep claims are traversed by the great East Rand dike which practically cuts the property into north and south sections. In both portions of the mine sand-filling is proceeding, and not only has it facilitated removal of the rich pillars hitherto employed as supporting agents, but also enables the operators to mine large areas of ground formerly inaccessible under ordinary working conditions. The sand is sent from the surface into the northern portion of the mine through a hole bored for the purpose, and the south section is supplied by way of a winze.

METHODS EMPLOYED ON THE RAND.

At the receiving terminals are placed rows of tanks commanding belt-conveyors. These deliver the product of two

sludge pumps where the sand is mixed with about four times its own weight of water. In this state it is too wet for direct loading into the workings and first passes to the dewatering station where six Caldecot dewatering cones, for each station, reduces the moisture to about 28 per cent. The amount of water to be used forms an important point, and varies somewhat in different properties because of natural conditions. Without a sufficient percentage of water the sand cannot be effectively delivered to the various portions of the mine, and if the amount of water is excessive it must be pumped out again. The quantity used at the Witwatersrand was decided on after a comprehensive series of tests, and has proven satisfactory in this particular instance. The cost attending surface handling of the sands are approximately the same as are entailed in dumping the residue, while underground costs are slightly over four cents per ton. It is thus readily apparent that the process is fairly inexpensive.

As a result of the installation the management states that the safety element has been materially increased, and damage to surface buildings by sliding ground virtually eliminated. It has also enabled the carrying on of operations on a larger scale, inasmuch as more extensive areas of ground may be worked at once without danger of caving. Besides it permits the extraction of columns of commercial quartz formerly left to aid the timbers in sustaining the weight of the hanging-wall. In the old workings of this property several of the pillars show signs of yielding to the excessive strain, and sand-filling has proven far superior to timbers in assisting the pillars in bearing the load, when it is not deemed advisable to extract the supporting columns. The operation of the sand-filling plant is practically automatic throughout, and requires little attention, save at the surface loading stations and points of application.

An earlier and likewise successful sand-filling plant is operated by the Cinderella Consolidated, one of the greatest of all Rand companies. To gain an adequate idea of the extent to which sand-filling has progressed on the Rand, and the extensive manner in which it is being utilized, a brief description of the Cinderella Cons. is appropriate. The mine embraces 2,100 claims in the East Rand section of the Main Reef field, with the holdings coursing along the strike of the reef for from 16,000 to 17,000 feet. The present main working shaft has an incline depth of over 7,100 feet. The company is sinking a new main shaft, the Central, which in many respects will be one of the most remarkable working avenues in any mining property in all the world. It has seven compartments, with inside dimensions of six by forty-two feet and will be eventually sent to a depth far exceeding the point attained by the old shaft.

The orebodies are of great size and carry usual Rand values, and late reports indicate an ore reserve considerably in excess of 750,000 tons. The reduction facilities consist of 100 1,650-pound stamps, three tube-mills and a comprehensive cyanide plant, giving a capacity of 22,000 tons per month. The company has experienced considerable loss and annoyance by so-called "air-blasts," the result of violent fractures and earth movements, a condition frequently attending operations in deep mines. The terriffic pressure of the superincumbent strata at such depths crushes down stopes and other workings, and the ground fracturing under the enormous pressure bears down timbers, supporting pillars and other sustaining devices. The rush of air naturally following the collapse of the workings gives the name to the "air-blast." In the deep mines of the Rand such an occurrence is not infrequent, and the Cinderella Consolidated temporarily lost three of its richest stopes in this manner less than a year ago.

CINDERELLA'S PRACTICAL SCHEME

The filling of Cinderalla Consolidated workings with sand is carried on through a wooden box launder, having inside dimensions of 11x12 inches, and carrying the sand to a total vertical depth of 3,900 feet when so desired. As the greatest strain from earth pressure is experienced at considerable depth, it is readily apparent that sand-filling is most frequently conducted in the bottom levels. The sand from the surface bins is delivered to the launder by a belt-conveyor, which replaces, the pipes and launder formerly employed for this purpose. The sand passes in a dry state to the launder, as tests demonstrated that when the sand contained more than four per cent of moisture it clung to the sides of the launder and speedily checked the flow of the material to the deep levels. The falling sand drops upon a sharply-inclined plate of iron, upon which a stream of water is directed. This forms a mixture which flows into a steeply pitched launder where the sand and water are more closely associated before passing to the pipes and launders which deliver the sand to the portions of the mine undergoing filling. The speed with which the filling is conducted, and the efficiency of the plant, depends largely on the amount of water constantly available for sluicing the mixture into the filling pipes and launders, as the delivery of sand from the surface bins to the shaft levels proceeds rapidly as long as the material is kept dry. In this state the sand drops freely down the box launder without touching the greater area of the box, but when the percentage of moisture exceeds five annoying consequences develop. A slight excess of moisture does not cause trouble provided the sides of the box are dry, but when seven per cent and upwards of water are present the sand adheres to the box, and its fall is naturally impeded. As the ratio of moisture increases the descent of the sand becomes correspondingly affected. It is for this reason that the sand should be relatively dry before using.

Attempts were at first made at the Cinderella Consolidated to overcome the clinging tendencies of the damp sand and increase its velocity by means of compressed air, but after repeated trials the attempt was abandoned as valueless. Another plan was the placement of a blower at top of launder, and establishing connections near the bottom with the intake of a ventilating fan, but this also was found impracticable, and the only satisfactory method proved the handling of a dry product.

Aside from the advantage derived by the employment of sand for filling, there is the additional one of reducing the amount of water to be pumped from a mine of average wetness. The sand sent into the Cinderella Consolidated has a moisture of three per cent and it is estimated that about 8,000 gallons of water are used in the mine each day in connection with the sand-filling work. Under other conditions it would be necessary to elevate this water 4,000 feet, consequently the employment of the practice lowers the pumping costs to a fair extent. The filling is in charge of an expert timberman, but the other work is performed by native and unskilled white labor. Total costs approximate five cents per ton for underground work.

The Cinderella Consolidated method differs considerably from the one employed at the Witwatersrand Deep, as readily appears upon examination. By the use of its apparatus the Cinderella Consolidated avoids the use of dewatering machines, but is under the necessity of maintaining an exceptionally dry product on surface. The method is favored by many Rand companies when continuous filling is not required, otherwise wet weather would greatly diminish its efficiency by making the sand too damp for rapid work. The simplicity of the Cinderella Consolidated

method is its strongest recommendation, aside from the excellent results obtained under favorable working conditions.

In using the Cinderella Consolidated method it is recommended that the sand contain not more than three to six per cent of moisture. Because of this it is inexpedient to use the sands direct from tanks, and the material should be exposed to the action of sun and air at least two days before using. This not only reduces the moisture sufficiently, but also neutralizes the cyanide or destroys its powers. Attempts were at first made by the inventors of this method to neutralize the cyanide with potassium permanganate, but it was found that the treated product when brought into contact with the ordinary acid mine water developed cyanogen gas. The presence of this terribly poisonous element in a mine must naturally be prevented, and it has been found best to expose the sand to the sun and air several days.

The box launder was adopted after several tests with iron pipes, and its success has been convincingly proven. It was originally intended to mix the sand and water on surface, the usual practice, and send the mixture down the shaft, but the excessive wear of the pipes, largely because of the great depth to which the product was carried, led to the contriving of the present method. The box launder should be placed in the driest of the shaft compartments on the down-cast side, and the outside tarred if sand containing as high as nine per cent water is used.

An exhaustive series of tests carried on by the Cinderella people conclusively proved that sand containing ten per cent and upward of water could not be advantageously used, because of the impossibility of keeping the launder free of the clinging material. Whenever the launder becomes choked with sand a stream of water is used to sluice it out. The ever present possibility of such an occurrence makes it essential that a dependable bell-signal service, or similar arrangement be maintained between the surface bins and the filling point, also that an ample water supply be constantly available for the clearing of the choked launder.

The rate at which the sand should be supplied depends to some extent on the experience of the labor, for it must not be fed too swiftly or it develops a tendency to crowd the bottom sections of the box, while it must be delivered at a sufficient speed to insure a good velocity. At the Cinderella Consolidated the launder is provided with observation doors at every 100 feet, enabling the operators to readily detect cause of any troubles that may develop. With sufficient water for sluicing and the sand fairly dry, there is little trouble in maintaining a satisfactory flow of the sand.

The process employed by the Witwatersrand Deep Co. is the one most generally favored by Rand operators, and may be considered a standard method of sand-filling. The sand is taken direct from the tanks, and the free cyanide neutralized by feeding potassium permanganate into the pulp. Tests of the treated product are made regularly to detect any trace of free cyanide and prevent its passage into the mine workings. It is essential that the sand used in filling be sufficiently moist to pack well, as a too dry product is more difficult to handle and flows through the supplying pipes and launders less readily. Yet the product must not be too moist, or the necessity of pumping out the excess water means loss of time and added expense.

While the management of the Witwatersrand Deep uses an admixture of seventy-two parts sand and twenty-eight parts water, the property is an exceedingly wet mine and the use of a very moist sand is carefully guarded against. The company is pumping about 1,500,000 gallons per day at present, and a few months ago was handling 2,000,000 gallons. The excessive wetness of this mine is attributed to the big transverse dike which cuts through a portion of the Witwatersrand Deep and neighboring properties. Within a short time it is expected the powerful new pumping system of the East Rand Proprietary company will relieve the Witwatersrand Deep of a considerable portion of the water, in which event it is possible the proportion of water used in the sand filling will be increased.

SAND FILLING SPELLS MINE SAFETY.

In many of the dry mines of America it probably would be found desirable to employ a mixture containing considerably more water to insure best results. Sand-filling may be carried on very much as ordinary timbering, as the timberman in charge of the work completes the placement of the sand in the workings as the ore is removed. In this way there is no necessity for leaving large open chambers unsupported for any length of time, and caves or movements of ground toward the shafts, are effectively controlled. The total costs of sand filling on the Rand varies from ten to twenty-four cents per ton, including surface handling. It costs about ten cents per ton to handle the sands from the tanks and store on the dumps in ordinary practice. It is thus apparent that the sand can be sent down to the mine levels almost as cheaply as it can be stored on surface.

The danger of caves in deep mines, and resultant airblasts of terrific severity, is intensified by the room and pillar method of mining and similar practices, and it is under such conditions that the use of sand for filling of the old working claims particular attention. The pillar and room method means large open spaces, and a large open stope is a source of positive danger. In many mines worked by this method the men labor under cover, the guarding pillars protecting them from sudden caves of the hanging-wall. The pillars are subsequently removed by top-slicing. But there is always the possibility of the ground crushing down the supports, unless a large number of pillars are provided. The method is dependent for success upon the bringing down of the capping evenly and regularly, and it is economically necessary that the maximum quantity of ore be caved down in the shortest possible period of time. The method has been developed along particularly successful lines in the Lake Superior district, and it is notable that airblasts are very common in this region.

As before stated an airblast is caused by intense compression of air in a confined space. The fall of an enormous tonnage of rock into a large empty stope hurls a crushing wave of compressed air through the mine very much as a similar wave is set in action by a gas or dust explosion in a coal mine. The rushing blast of air sweeps timbers, cars and men along with tremendous force, and such blasts have often caused heavy loss of life and considerable property damage. It is not to be concluded that airblasts are always the result of caving methods of mining, for disastrous blasts of this character have frequently occurred in more restricted workings. They were not unknown on the Comstock when that famous lode was at the zenith of its glory, and have developed in most of the deep mining regions of the world.

DESTRUCTIVE FORCE OF AIR-BLASTS.

A convincing demonstration of the terrific force of an airblast, and its deadly properties, was recently evidenced at the Miami copper mine, where three men were killed, seven seriously injured, and others hurt in minor ways by the swirling blast of air driven from 245-foot level by the collapsing of capping estimated to comprise 3,000,000 tons. In this mine the men work under protecting pillars, and the falling rock itself caused little damage. But the cave drove the compressed air forth at ter-

rific velocity, carrying death and destruction into the nearby drifts. The resistless nature of the blast was evidenced by the driving of a seven-ton motor and fifteen ore cars along the track for 200 feet, despite the desperate efforts of the motorman to check the terrific force of the rushing wind. In foreign fields the airblast has been a most destructive agent, and the frequent occurrence of such accidents on the Rand was one of the prime reasons for adopting the sand-filling method.

The danger of airblasts has been given little consideration by metal miners in the past, although numerous precautions have been taken to guard against the danger of falling masses of rock. The series of airblasts recently occuring in many districts, however, particularly in deep mines and where large stopes are worked, have awakened managers to the presence of an element of peril that must be guarded against as carefully as other potential sources of danger. It is universally conceded that the most dependable guardian against the airblast is an adequate support of the roof of the underground workings, but conditions are frequently of such a nature that close timbering is economically impracticable. In many districts timbers are difficult to secure, and costly to install, while the margin of profit attendant on mine production is so limited that the management does not feel justified in assuming further expenses.

Under the present exigencies of the commercial era, each mining company is endeavoring to rush production. Practically every progressive manager is striving to extract the largest possible quantity of ore within a specified time, and the earning of maximum profits forms the chief consideration. But such a practice has its draw-backs and penalties, and the insufficient support of heavy ground too often entails subsequent costs and delays.

When the lessons of Rand mining are studied and analyzed, and it is realized that the sand-filling method has only been adopted after years of comprehensive and intelligent trials by the leading Transvaal companies, it seems strange that the practice has not been given greater approval by American operators. The method was not employed by the Rand companies before its merit had been definitely established, and while most managers admit there are many opportunities for improving the system, it has incontestibly saved an immense sum to several operators, and facilitated extraction of ore from sections of ground previously inaccessible. Not only has sand-filling proven of inestimable benefit in protecting the mine from the effects of disastrous caves, but has also increased the important factor of personal safety whenever employed. ,And the human factor, the adequate protection of the employees, must be considered. Unless the miners know they are working in a fairly safe stope, with all possible precautions exercised to secure them from accidents, they cannot be expected to remain satisfied with conditions, nor to do their best work. No man can give his best, when he knows that danger constantly hovers near. And no man will work for long in a property he knows to be absolutely unsafe. Furthermore, it is the duty of the company to protect its men to the utmost of its ability. And as a means of protection the sand-filled workings have demonstrated their worth. The subject is commencing to claim some attention in America, and has been given a trial in some instances, but has yet to be given the support by the mining fraternity to which Rand results prove it to be entitled.

ELECTRIC FURNACE SMELTING

Elsewhere in this issue of Mines and Methods there appears an article on the subject of zinc smelting with the electric furnace prepared by Mr. Peter E. Peterson, mining engineer, of Butte, Montana.

It will be of interest to readers of this journal to know that the author conducted his experiments as therein outlined on the Butte and Superior property using, in part, ore and concentrate from that company's mine and concentrator for the purpose. The practicability of the furnace was fully demonstrated.

During the period of experimental operations by Mr. Peterson, and immediately following the inauguration of a new management represented by Utah Copper interests, the announcement was officially made that, in lieu of the treatment of Butte and Superior mine-run ore by established "wet" methods of concentration, a new "dry" process would be installed, which latter would afford a production cost for spelter lower than that obtaining elsewhere in the mining world. The "dry" process mentioned, so we are informed, considered the treatment of the mine-run ore in the electric furnace and the direct production of refined spelter on the property, thereby eliminating the necessity for a preliminary ore-dressing and shipment of concentrate to eastern zinc smelteries for further refining. Though negotiations had been entered into between the management and Mr. Peterson for use of the electric furnace process, later they were declared off. Then followed the "remodeling" of the original efficient concentrating method by installing the "Garfield" system of milling—as outlined in earlier issues of this journal—which in turn was abandoned.

Ways and means should be devised at every mine, large or small, to determine, at least approximately, what the value of its product is before shipping. Whether this knowledge is gained by actual sampling of the ore in the mine before it is broken, or afterwards, by various methods usually employed, will depend on local conditions.

Breathing can usually be restored after an electric shock within an hour, says Coal Age. Keep up artificial breathing for this length of time at least After breathing starts, begin to restore the circulation by rubbing the limbs briskly in the direction of the heart and under the covers with which the patient has been previously covered.

The fire-fly produces light in a very efficient way. The spectrum of the emitted light consists of a narrow band in the yellowish-green portion of the visible rays, apparently unaccompanied by any emissions in the ultra-violet or ultra-red portions. When oxygen is absent no light is given out, and the light is not necessarily connected with the life of the insect. The abdominal material, when dried and powdered, may be kept for two years, and it will then emit light if moistened and exposed to oxygen. As yet chemistry has been unable to duplicate this result.

Rain-water collected after a long period of wet weather is the most natural water. It contains atmospheric air and gases in the proportion of about 2.5 cubic inches to every 100 cubic inches of water. River water is the next purest, then comes the water of lakes, ponds, ordinary spring and mineral springs. Following these waters comes arms of the ocean lying in the vicinity of the mouth or discharge of great rivers, then follows the water of the main ocean and last of all the waters of lakes, like the Dead Sea, Caspian Sea, and the Salt Lake of Utah. Spring water although perfectly transparent contains more or less mineral matter dissolved in it. The nature of these impurities will depend on the character of the soil through which the water percolates. The most general impurities are carbonate of lime, common salt, sulphate of lime (sometimes called gypsum) sulphate and carbonate of magnesia and compounds of iron Most spring waters contain a certain proportion of carbonic acid gas.

THE ELECTRIC FURNACE FOR SMELTING ZINC ORES

By PETER E. PETERSON.*

From the nature of the present retort method of recovering zinc from zinc concentrates it is almost impossible to conceive of any improvement therein

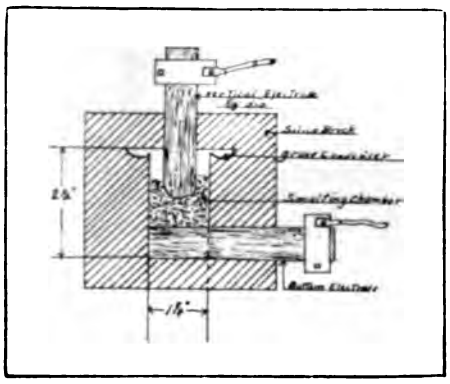

Fig. 1.

that would lead to increased capacity and decreased costs, let alone the possible recovery of zinc from the abundant complex zinc ores (containing copper, gold, silver, lead and iron) at a reasonable cost and appreciable recovery of the other metals.

The metallurgy of zinc is one of distillation. The zinc must be vaporized at a high temperature, and in a reducing atmosphere. Outside of the retorts the electric furnace is the only smelting device that can meet these conditions, and seems to hold out the only hope for improvement in zinc smelting.

The possible apparent advantages are: Large units continuous feed and discharge and the recovery of gold, silver, copper and lead in the form of copper matte or lead bullion.

The problems encountered in building a furnace to make the above advantages a reality have been many, and perhaps much time and work can be saved to others by a discussion on different types of furnaces employed.

THE FIRST FURNACE.

Fig. 1 shows a vertical section of the first furnace experimented with. This furnace had no opening to the outside, although there was some leakage of gas around the upper electrode. The charge consisted of mixture of zinc sulphide, copper sulphide, lead sulphide and iron sulphide, and sufficient metallic iron to desulphurize the zinc sulphide ($ZnS+Fe = Zn+FeS$). The furnace was connected to small direct-current generator and run at the rate of 4 kws. per hour, the amperes varying from 40 to 50.

There was no way of telling when the charge was smelted, so a series of runs were made ranging from 1 to 3 hours. At the end of 3 hours the charge was completely smelted. The resulting matte showed from 1 to 2% zinc and small shots of metallic lead, while 95% of zinc in the charge was recovered in form of a high-grade spelter assaying 99.8% zinc. The 3-hour run was repeated and practically the same results obtained. Another furnace was built with a condensing chamber on one side with a small opening for escape of gases. With this furnace it was not possible to condense the zinc to spelter, it being condensed in the form of blue powder.

LARGE FURNACE BUILT.

Results with these small furnaces were so encouraging (and there seemed to be

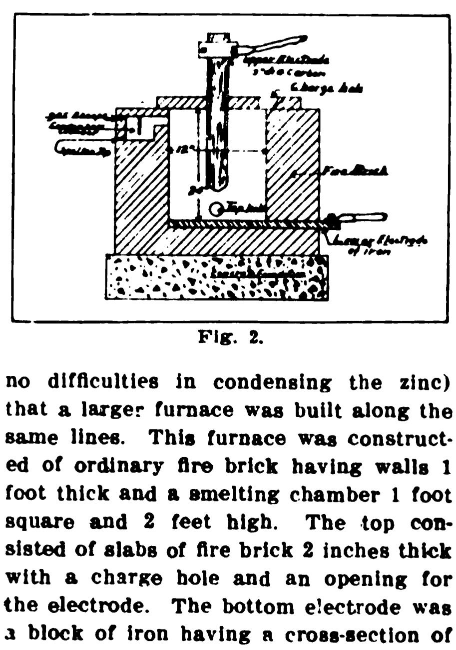

Fig. 2.

no difficulties in condensing the zinc) that a larger furnace was built along the same lines. This furnace was constructed of ordinary fire brick having walls 1 foot thick and a smelting chamber 1 foot square and 2 feet high. The top consisted of slabs of fire brick 2 inches thick with a charge hole and an opening for the electrode. The bottom electrode was a block of iron having a cross-section of 1 inch by 12 inches, extending through the wall and protruding 8 inches. The vertical electrode was a carbon rod 2 inches in diameter and 4 feet long. This furnace had a rectangular condensing chamber 6 by 6 by 12 inches with a baffle running the long way, causing the gases to circulate first down one side and then up the other. There was a small opening ¼-inch in diameter at one side of the condenser for the escape of gases. (See Fig. 2).

The furnace charge used consisted of unroasted zinc concentrate analyzing as follows: 47.81% Zn, 9.21 insoluble, 6.2% Fe, 1.5% Mn, 30.32 S, 1.4 Cu, 0.035 oz. Au and 12.2 ozs. Ag. Scrap iron was added to desulphurize the zinc.

The power was obtained from 50-kw. alternating transformer. The electrodes were connected to 110 volt circuit, and in series with the circuit was packed a choke coil to protect the transformers in case of short-circuit, and at the same time to somewhat regulate the current.

Numerous runs varying from 4 to 12 hours were made. The condensing arrangement failed to condense anything but blue powder. The furnace consumption was irregular, and consequently the heat was the same. Attempts were made to tap the furnace, but were not very successful, although some slag and matte was tapped which analyzed as follows: Slag—Zn 4%, Cu 0.19%, FeO 11.1%, Au trace, Ag .35 oz. Mn 0.6%, SiO_2 64.65%. Matte—Zn 1.3%, Fe 60.4%, S 29.35%, Au 0.03 oz., Ag 9.4 ozs., Cu 1.70%. The analysis of the slag and matte is interesting and showed the possibilities of the process.

CHANGE IN CONDENSERS.

The furnace was next equipped with a 2-inch iron pipe, 2 feet long, for a condenser. This pipe was flush with inside, and stuck out a foot into the air. With this arrangement it was possible to condense some spelter after an hour's run, which allowed time to heat the condenser up to the condensing temperature. At this stage of the experimenting

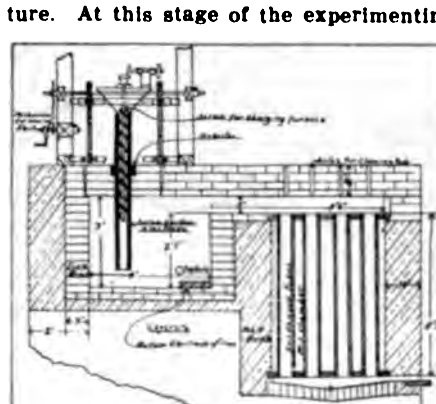

Fig. 3.

it was evident that for successful condensation of volatilized zinc to spelter, there must be some way of controlling the temperature. The next experiment

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consisted of a 2-inch iron pipe 6 feet long, extending across the top of the inside of the furnace with series of holes bored into the upper side of pipe for the admission of zinc vapors, the theory of the apparatus being that with a long pipe,

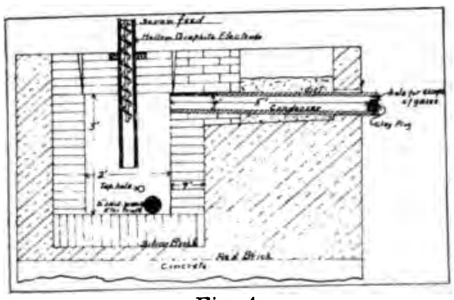

Fig. 4.

one end cold the other hot, between these two temperature extremes there would always be a zone of the proper condensing temperature.

This condenser gave fair results. Starting the furnace cold at the end of an hour, it was noticed that condensing commenced and would continue at a good efficiency for an hour; when the condensers seemed to get too hot, or rather the zone of proper condensing temperature was greatly reduced in area. Various means were tried to increase the length of this condensing zone.

A larger pipe 8-inches in diameter was inclosed with brick and heated with coal. Clay tubes of varying lengths and thickness were tried. Iron pipe insulated with varying thickness of asbestos, and chambers of varying dimension in the wall of the furnace, was experimented with, but none of these gave better results than the 2-inch pipe 6 feet long.

The problem seemed to resolve itself into three parts; that is, a certain temperature was found to be necessary as well as a certain area, and that this area must not be too far away from the source of distillation. In other words, the zinc must not be kept in a vapor form too long before condensing. The furnace seemed to stand up well, except the cover, and this usually did not last more than a couple of days.

FURTHER DEVELOPMENT.

The bottom electrode, although of iron, gave no trouble, which was no doubt due to the shortness of the runs. Up to this time there was no very definite idea of costs, such as electrode and power consumption, so another furnace was built of the same type and an effort made to run a ton of zinc concentrates in one run, keeping careful record of the power and electrode consumption, disregarding entirely the condensing of the zinc to spelter. This run was in two parts, one using metallic iron as a reducing agent and the other using lime and coke, according to the following reaction: $ZnS + CaO + C = Zn + CaS + CO$.

The following results were obtained:

Reducing agent—	Iron.	Lime and coke.
Kw-hours consumed	360	388
Pounds ore smelted	455	363
Pounds reducing agent	193	197[1]
Total pounds of charge	648	560
Kw-hour per pound charge	556	692
Kw-hour per pound zinc contrates	79	1.07
Kw-hour per ton zinc concentrates	1580	2140
Kw-hours per ton zinc concen-		
Per cent of zinc extracted obtained by difference	90	50

[1]164 lbs. lime; 33 lbs. coke.

The above test using iron as a reducing agent, was made in three separate runs, the furnace being allowed to cool down between runs. In using lime and coke the furnace was allowed to cool down four times. Copper coated carbon electrodes, 3 inches in diameter were used, and the carbon consumption per ton of zinc concentrates was 12 lbs. This furnace was lined with magnesite brick. The run did not show them to be superior to fire brick. Under these conditions the cover of the furnace suffered the most and had to be replaced twice. The power consumption varied greatly, and it required constant moving of the electrode by the operator to keep the furnace running. The furnace was charged once an hour by means of hopper with a slide in the bottom. Immediately after charging the zinc vapor issued from the ends of the condenser with great velocity, due to the small amounts of moisture present. The charge was not preheated as it should have been. There was no separation of slag and matte. An analysis of the material tapped from the part of the run using lime and coke for reducing agent is as follows:

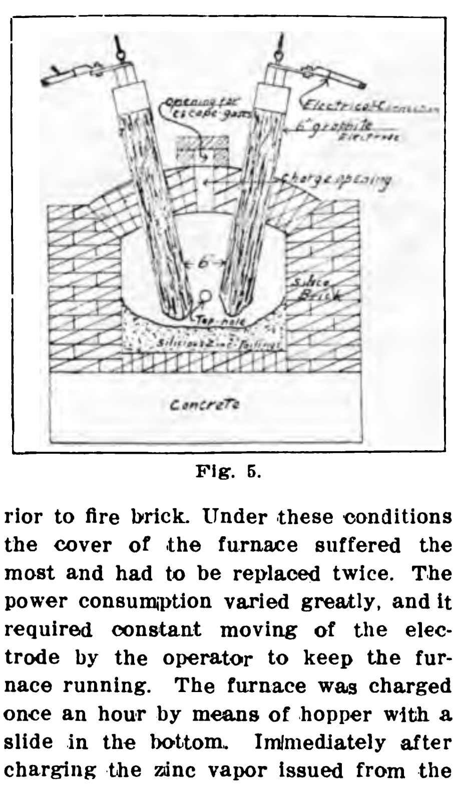

Fig. 5.

% Insoluble	% FeO	% S	% Zn	% CaO
8.6	13.2	24.3	24.3	25.1

At this time it was decided that the most economical method of treating zinc concentrates could be attained by roasting them to oxide, but leaving sufficient sulphur to form a matte as a collector for the precious metals. After some experimenting the practicability of the following reaction was proved:

$$Fe_2O_3 + 3C + 2ZnS = 2Zn + 2FeS + 3CO.$$

By this method the major part of the zinc is reduced from the zinc oxide by carbon, and the zinc in the sulphide form is reduced by iron, which has been reduced by carbon from iron oxide.

THIRD FURNACE BUILT.

The next furnace constructed was to have a capacity of 1 ton of roasted zinc concentrates per day. The furnace was a radical departure from anything previously tried. The charge was fed into the furnace through the upper electrode so as to introduce it directly into the arc. There were eight clay condensing tubes inclosed by heavy brick walls with an arrangement to cool the tubes as rose above the condensing temperature. (Fig. 3 shows drawing of this furnace).

The condensing tubes being inclosed in heavy brick walls, it was thought that in time, about two or three days, the condensers would become over heated from the zinc vapors, and then it was proposed that the tubes be cooled to the right condensing temperature by air. This condensing temperature we were led to believe was between 450 and 515° C. Ingalls' book on Zinc Smelting gives these figures. Later this condensing temperature was determined to be above 864° C. This is also consistent with theory when it is considered that zinc boils under normal conditions at about 920° C.

CONDENSER DIFFICULTY.

After several runs lasting from two to six days it was found impossible to heat the condensers to 450° C. let alone 864°. The zinc was condensed in the form of blue powder as was to be expected.

The brick work in this furnace was put in with all possible care, yet frequent explosions resulted from the leakage of CO gases into the air chamber surrounding the condensers. The openings were continually choking up with blue powder, and it was found rather hard to keep them clean. This character of condensing apparatus was too complicated to offer any success.

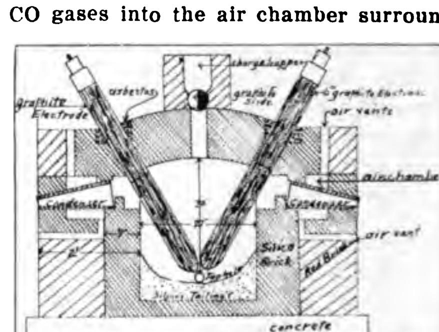

Fig. 6.

The expected improvements in smelting gave considerable trouble. The furnace was connected up without any regulating device to control the power, and as a consequence it was found impossible to keep a constant heat. The charge was intended to be fed continuously through the hollow electrode by a screw, but due to variance of fusing the feed was continuously choking. The object of charging in this manner was to obtain lower power consumption per ton of charge. This was accomplished.

MECHANICAL DIFFICULTIES.

The power consumed was from 1,100 to 1,300 kw.-hours per ton of 50% zinc concentrates, but the mechanical difficulties still existed. The hollow carbons gave considerable trouble by breaking. Later graphite tubes were used which gave better results. The bottom electrode which was of iron, as in the former furnaces, melted and destroyed the bottom of the furnace with it. The furnace cover showed no deterioration whatever.

The furnace was remodeled. (See Fig. 4). In place of the iron electrode in the bottom a 6-inch diameter graphite electrode was substituted. The smelting chamber was reduced in size and a water rheostat was placed in series with the circuit as a means to control the power.

The condensing apparatus was replaced by three clay tubes 1 inch thick, 4 inches inside diameter and 5 feet long. These were placed in a shallow brick chamber open at the top. These condensers were covered with varying thicknesses of dirt, as it was thought necessary to maintain the condensing temperature. With this device some spelter was obtained. From 4 to 5 inches of each tube was doing the condensing, and the greater part of each tube was too cold to condense. The condensing apparatus was next replaced by eight tubes 1 inch thick and 4 inches inside diameter, all of different lengths varying from 14 to 28 inches, two of these tubes were of carbon; the rest were of clay, and two of the clay tubes were partially filled with charcoal.

The ends of these condensers were luted with clay, leaving about ⅝-inch diameter hole for the escape of CO gases and uncondensed zinc vapor. Pyrometers were constantly kept in the tubes. No zinc could be condensed unless the inside surface of the condensers was above 840° C., and at 900° the condensers were too hot. The carbon tubes condensed no better than the clay tubes; the clay tubes containing charcoal did not condense quite as well as tubes without.

At no time during this run was the zinc completely condensed for there was always uncondensed zinc burning at the ends of tubes, and at all times the condensers would condense spelter if the temperature was around 864° C. From these results it was concluded that each of the tubes had a limited condensing capacity, and if the tubes were kept at 864° C., and the amount of zinc volatilized kept within the limits of the condensing capacity of tubes, there would be practically a complete condensation of the zinc.

PRODUCES SPELTER.

Another change was made in the furnace. Solid graphite electrodes 6 inches

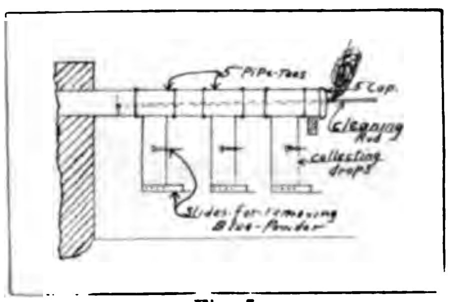

Fig. 7.

in diameter were used in place of the hollow ones, and charge was introduced by means of a screw through one side and near the top of the smelting chamber. The furnace was run on barren charge until the condensers attained a temperature of 859° C., then a charge containing zinc was introduced and fed at a rate so that very little zinc appeared in the flames burning at the ends of the condensers. This maintained for 12 hours and the spelter condensed and recovered was 86.4% of the amount charged into the furnace. Thus at last

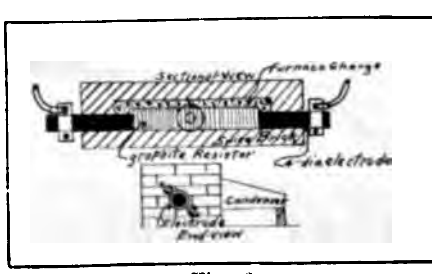

Fig. 8.

it was proved that spelter could be made with the electric furnace but it was observed that the power consumption was approximately 4,000 kw.-hours per ton of 50% zinc concentrates.

The furnace bottom was giving trouble; it melted out almost as readily as the charge. This complicated matters making slag thick and pasty, and only occasionally did any matte appear with the slag, but the matte was always found when a furnace was torn down. The bottom electrode was consumed at about the same rate as the vertical one. This and other reasons made the furnace exceedingly hard to control. The destruction of the furnace bottom was attributed to the arrangement of the electrodes.

The condensation of zinc requires constant conditions, such as a quite uniform flow of gases, and a constant heat which could be easily varied. The next step was to improve the smelting part. A small furnace was erected with two electrodes through the top. (See Fig. 5.) These were placed about 6 inches apart. The inside of the furnace was lined with silica brick and the bottom covered 10 inches deep with siliceous zinc tailings from mill jigs. No efforts were made at the condensation of spelter, the zinc fumes passing into a flue and allowed to go to waste.

With this furnace numerous runs were made covering a period of 30 days. Slags of different composition were tried and the proportion of reducing carbon was determined. This work resulted in much useful information concerning furnace charges. We had no difficulty whatever in making slag and mattes and tapping them from the furnace, and the power or heat could be kept constant or varied at will with practically no attention. Test runs on recovery of metals and power and electrode consumption were very satisfactory. The furnace was torn down and showed practically no deterioration whatever, in fact part of the tailings from the furnace bottom were not altered.

CONICAL CONDENSERS.

A larger furnace was constructed along these lines fitted with eight conical condensers, such as used by the zinc smelters in Kansas and Oklahoma. A run was started and for the first 24 hours was encouraging. Then the old trouble returned. The furnace would not respond to regulation and no slag could be tapped. The apparent electrode consumption was enormous; 20 feet of 6-inch diameter solid graphite electrodes were fed into the furnace in six days time. Something was radically wrong, and on opening the furnace it was found that a hole 6 feet below the bottom had been melted out. The electrode consumption had been very little, the electrodes when removed were 12 and 14 feet long respectively. The trouble was caused by the arrangement of the electrodes. The operators in attempting to regulate the power had lowered the electrodes through the bottom of the furnace.

The hole in the bottom of the furnace was filled with siliceous zinc tailings, and the electrodes placed at such an angle of each other (see Fig. 6), that when lowered they would meet at the bottom of the smelting chamber. The screw feed was abandoned owing to the irregularity of air supply used in run-

ning in, and charging of the furnace was accomplished by means of a brick hopper with a graphite electrode for a slide in the bottom.

The furnace as now arranged was smelting during actual running time for thirty days with five stops, during which time the furnace was allowed to get cold. During these runs the previous condensing experiences were repeated without any improvement. The spelter that was condensed was found remarkably pure, assaying from 99.3 to 99.8% zinc. The furnace gave no trouble in any way. Slag and matte were tapped every twelve hours.

For the time being the efforts at improving the condensers were abandoned and arrangements were made to recover all zinc products. To accomplish this a new furnace was built, and special iron condensers were made to recover the blue powder; also a bag house was used to catch the zinc oxide in fumes. (Fig. 7 shows view of blue powder condenser.) A 12-day run was made without difficulties of any kind. The charge was fed in every hour, and slag and matte tapped every twelve hours. The metallurgical results will appear in another article.

This furnace in its present improved form is about all that can be expected of any furnace. There are far less difficulties encountered than in running an ordinary blast furnace.

The deterioration of the furnace is small. Such a furnace should run from six months to a year without any extensive repairs. Large units can be constructed by merely the addition of more electrodes, and there is no reason why units of twenty-five to fifty tons each could not be operated as easily and cheaply as the one-ton units.

In connection with the condensing experiments a small register type of furnace was constructed. (See Fig. 8.) This furnace was made with a view to duplicating the conditions existing in the present day zinc retort, with the exception that electrical heat was used instead of gas or coal.

The essential parts of the furnace were a rectangular brick chamber having a resister of graphite blocks in the bottom, connected to an electrode at each end. The arrangement of this furnace was such that the heat was always under control. There was one condenser of the same type as used in retort smelting. The furnace was charged intermittently with roasted zinc concentrates and coke and coal.

In operating this furnace great care was taken in regulation of the heat so as to have the same conditions as in the retorts. It was noticed that the zinc began to volatilize before the condensers were hot enough to condense it to spelter, and that after the condensers had reached the right temperature, there was more zinc volatilized than it would condense, and when the heat was reduced to cut down the volume of zinc vapor, the condenser would get too cold. This condenser when at the right temperature which could be easily maintained, would condense two pounds of spelter per hour with approximately the same amount of zinc vapor passing through without condensing. There could be no doubt whatever as to the gases being of the same composition as in the retort.

These experiments were repeated a number of times, and the results were always the same. And to me they prove conclusively that the failure to condense zinc to spelter in the electric furnace is due to the difficulties in maintaining sufficient condensing area at the right temperature near the source of volatilization.

In another article will be described a condenser designed to meet these difficulties.

MICROSCOPY IN ECONOMIC GEOLOGY

By R. BECK.*

The great advances which have been made in the systematic and genetic knowledge of minerals and rocks since the application of the microscopic method of investigation are well known. So numerous are these results that they can hardly be comprehended. But a limit has already been reached, beyond which a fruitful development of the science through this means alone is scarcely to be expected. After a surprising number of unlooked for constituents were shown to be present in the rocks and thereby entirely new points of view had been opened up to systematics, the investigation of the structure or the manner of intergrowth of the constituent minerals of rocks was brought into the foreground, and attempts were made to draw important genetic conclusions from these results. It was found, however, that the bulk chemical composition of rocks, which had fallen into comparative neglect after the introduction of the microscope, as contrasted with the preceding period of the hand lens, was a significant genetic factor. Chemical analysis was therefore again established on a new basis, and its results successfully applied to genetic classification. But even then the goal was not attained. Experimentation, especially fusion in the electric problems, began to attain general importance in modern petrography. But here also the microscope is necessary; for by means of it thin sections of the natural occurrences are compared with sections obtained from artificial melts. It is evident that in this field petrography frequently comes in contact with metallurgy and especially with metallography.

EARLY PETROGRAPHERS NEGLECTED OPAQUE MINERALS.

Along the path of development which has just been sketched, petrography on the whole bothered itself but little with economic geology. The petrographers of the '70s and later, for example, treated with a certain disdain the disseminated ore minerals which are usually found as essential or accessory components of rocks. This is apparent in their vague designation of these as "opaque constituents." Different ores, as well as particles of carbon and graphite, were brought under this heading without further investigation. The fact was not heeded that these inclusions, in spite of their minute quantity, often plainly indicated the genesis of the rock in question. A miscroscopic investigation of the composition and structure of actual ore deposits was seldom attempted. Especially were the nonmetallic deposits avoided by the petrographer.

Happily, during the last decade these conditions have completely changed. Everywhere the importance of the microscopic method for the investigation of ore deposits of all kinds has been recognized, especially in the treatment of practical geological questions. Among the first and foremost in this work has been the Freiberg school of geologists, whose efforts have been rewarded with many important results.

It is not intended to relate here in chronological sequence the achievements of the microscopist in this field, but rather to give a review of the results that have been obtained, following in this the order of the systematic classification of ore deposits. The metallic deposits will first be taken up in accordance with the genetic classification in Beck's "Lehre von den Erzlagerstatten."

*This translation of the address delivered by Professor Beck on the occasion of his inauguration as rector of the Royal School of Mines at Freiberg. Saxony, October 3, 1911, was made with his permission by Joseph T. Singewald, Jr., of the geological department of Johns
Journal of May 31st.
Hopkins University. The German title is "Ueber die Bedeutung der Mikroskopie fur die Lagerstattenlehre." It is reproduced from the Engineering and Mining

INFLUENCE OF MICROSCOPE ON CONCEPTION OF MAGMATIC SEGREGATION.

In the very first genetic group, the magmatic segregations, we see that the microscopic apearance of a specimen often alone determines the entire conception of it. It is relatively easy to examine an ore which contains only one ore mineral in addition to the silicates and other minerals which are transparent in thin section. To distinguish several opaque minerals from one another is more difficult. For this purpose reflected light is being used with great success by means of a simple vertical illuminator, or even by direct cases, highly polished surfaces are prepared and electrically illuminated in the Le Chatelier metallographic apparatus. The different ores can then be still further distinguished through careful etching; and recently artificial tarnishing has also been produced and used in the diagnosis. In this way it is possible to determine the order of deposition of the different minerals, and hence gain a valuable insight into their mode of origin.

The study of the platinum of the Urals might be cited. By this means, it was shown that the grains possess a zonal structure, such as is typical for crystals formed from a molten mass, as the augites in basalts or the feldspars in many porphyries. On the other hand, it was brought out that before the separation of the platinum, the separation of the chromite was already complete. Further, it could be shown in some cases where the platinum contained considerable osmium and iridium that crystals of osmiridium or newjanskite were scattered through the platinum trains, their separation taking place therefore between that of the chromite and that of the platinum. The last member of the sequence was always a silicate, olivine. All these observations established the segregation of the rare metal from the molten magma, also in those cases where the platinum occurred together with magnetite intergrown in a pyroxene rock. In the same way the origin of gold has been determined, such as the primary gold in the silicates of certain gabbro-diorites of Madagascar. If, on the other hand, the microscope discloses that, in any igneous rock whatever, native gold is found only where secondary quartz and pyrite occur, then the subsequent introduction of auriferous solutions must be assumed; this is the case in many of the supposedly primary gold-bearing diabases and epidiorites of Australia.

The theory of the magmatic origin of many oxidic chromium and iron ores was greatly fortified by means of the microscope. We know now with certainty that all workable chrome-iron ores were derived from magnesia-rich magmas. The origin of the gigantic ore deposits of Lapland was also worked out primarily through the use of the microscope, though aided by geological field investigations and boring operations conducted by the mining interests.

APPLICATION TO PROBLEM OF SUDBURY ORES.

The problem of the sulphides in the gabbros norites and diabases was more difficult. He who is familiar with the literature on the important deposit of Sudbury as well as that on the small occurrences at Sohland, on the Spree and Schluckenau, knows how difficult it was for geology to arrive at a generally accepted genetic conception of these ores. The microscope has shown that the old view of the magmatic nature of these ores applies to the extent that a part of the existing nickeliferous pyrrhotite and chalcopyrite actually must have segregated direct from the molten magma; and in the case of the great Canadian deposits this was by far the greater part. On the other hand, thin sections show that probably a thermal solution and redeposition of finely divided ore particles took place, giving rise to the formation of compact secondary masses of ore. A metamorphism of the rock preceded this redeposition, so that the secondary green hornblende, which is attached to the pyroxenes in delicate fringes, is in turn surrounded by pyrrhotite. The nickel content of the pyrrhotite is now also explained. The microscopy of highly polished surfaces established as true what had already been indicated as probable, through small-scale magmatic separation, namely, that there is an intimate mechanical intergrowth of common pyrrhotite and a nickel sulphide, pentlandite. The intergrowth is unfortunately so intimate that a commercial concentration is out of the question.

The modern conception of the next group, the contact metamorphic ore deposits, has been made possible largely through the microscope. Often the investigation of a single small sample of such ore suffices to make clear at once its genetic position, since structure and paragenesis are extremely characteristic here. Whoever knows how in accordance with the experience of the last decade the economic value of such contact metamorphic deposits has turned out in comparison with that of the magmatic or other types, will also know how to make commercial use of such a preliminary diagnosis when the occasion arises.

APPLICATION TO FIELD OF THE VEINS.

Within the field of the veins, one group of phenomena in particular has been elucidated, that concerning the replacement processes, or metasomatism. Of course, in certain vein-types these processes were understood in the pre-microscopic period as for example in the tin veins. Charpentier in his day pictured the steep-dipping tin veins of Geyer, which, together with the flat veins, are splendidly exposed, and he described very clearly how in the transition zones the feldspars of the granites were altered to gray quartz, besides cassiterite, arsenopyrite and other ores. The microscope, however, pointed out such phenomena in other vein groups with unexpected frequency. Only with its aid could we, for instance, understand the nature of sericitization, which is so widespread; and only thus were we able to recognize the same transformation along the courses of active thermal springs. It was found that replacement occurs not only in the country rock in place or included in the vein mass; but also in the vein material itself. The microscope decides whether the quartz is a primary deposit or whether silicic acid has subsequently replaced carbonate gangue minerals and barite, as at Schneeberg, or siderite, as in the Sieg district.

REPLACEMENT PROCESSES SHOWN AS OCCURRING IN EPIGENETIC DEPOSITS.

On a far larger scale the microscope has shown replacement processes to have occurred in stock-shaped and bedded, epigenetic deposits. Here, in particular, have thin sections proved, through the presence of fossils replaced by ore whether a cavity was formed and then filled with ore, or whether the original rock was replaced molecule by molecule with the metallic compounds.

There were problems of the greatest scientific and economic interest in the field of the epigenetic bedded deposits, in the solution of which no progress could have been made without the new method. Among others, the problem of the Witwatersand suggests itself here, calling for an abundance of nice investigations, part of which belong to the best known microscopic-petrographic achievements. The microscope soon showed that the early conception of this most famous gold deposit of the world as a complex of fossil gold placers, was erroneous. In its place, it gradually unfolded a picture of chemical-geological processes far more complicated than at first suspected.

These few suggestions indicate that the purely scientific progress attained by the

the ridge and the two bounding valleys it is pertinent to consider the condition of a concentration of solutions underneath the main drainage line of the basins rather than on the side of the basin; provided, of course, that the topography is sufficiently mature and has had time to permit the concentration of solutions under the central drainage lines, and further, that the copper solutions down the axis of the valley have not been diluted to the point that they will not precipitate in quantities sufficient to produce commercial orebodies.

TOPOGRAPHIC AND CLIMATIC CONDITIONS.

Topographic and climatic conditions are very important factors in the development of a commercially valuable disseminated copper deposit. Extreme youth of an area representative of original mineralization, when accompanied by intensive erosion of the surface, results in a very slow enrichment due to the fact that the necessary processes are not allowed to be completed before the material is removed; consequently, if enrichment is at all evident generally it is confined to the upper horizons and is merely superficial. Ordinary youthful topography, assisted by reasonably vigorous erosion of the surface, affords a better condition, while a thoroughly matured topography results in enrichment under the drainage lines. Influencing factors are changes in topography and general structure of the rock mass through subsequent regional earth movements, and it may happen that after a partial completion of enrichment over a given area that there has been a change which will afford either better or worse conditions relatively thereto.

An essential condition seems to be considerable variation in climate over long intervals of time. Semi-arid to arid climates afford satisfactory conditions under certain circumstances. Wide variation of temperature and sufficient moisture accompanied by relatively high temperatures accelerate decomposition of the exposed surface. In this connection it is pertinent to observe that these conditions are the more nearly met in the semi-arid or arid regions than elsewhere, chiefly at altitudes ranging from 4,000 feet and upward above sea level.

PHYSICAL AND CHEMICAL CONDITIONS.

Rock composition generally is the controlling factor governing secondary sulphide enrichment. Dependent upon the power of resistance to physical disintegration orebodies will be formed relatively to the structural conditions surrounding the rock mass. If the intrusive igneous rock, or its metamorphic derivatives, present a compact, unyielding mass not readily amenable to the weathering agencies, it is not likely that enrichment will extend to any great depth; in fact, there will be little or no change in the original mineralization as represented therein. On the other hand, where the rock mass presents a physical structure susceptible to disintegration through weathering processes the condition then is conducive to the formation of secondary sulphide deposits. This is best illustrated, perhaps, by the fact that, where the composition of a rock mass of original mineralization is such that it is subjected to physical disintegration and chemical alteration by exposure to weathering agencies, the exposed portion containing original minerals will be thoroughly oxidized and the copper mineral content thereof in part carried to a lower horizon as an enrichment product, leaving a leached zone of barren capping on the surface proportionate to the intensity of oxidation.

Where conditions are favorable, and the original mineralization carried a relatively high iron pyrite content, it is not unusual to note outcrops of leached areas of capping, or barren rock, composed chiefly of impure hematite representative of the superficial alteration of the exposed surface of the mineral deposit. Generally the more hematite the capping shows, the more iron sulphide will be found in the fresh ore at a lower horizon. Often the residual products of pyrite oxidation are carried by surface waters into adjoining porous rocks impregnating them to the extent that they simulate the original leached area. It follows, therefore, that the apparent area of superficial alteration represented by the iron capping does not indicate the existence thereunder of an enriched zone, only as referred to the original copper mineral content of the mass relatively to the structural conditions obtaining.

Altered areas represented by iron capping do not invariably indicate zones of copper sulphide enrichment, nor is it necessary that there be present any iron capping whatever, as many large deposits show merely inconspicuous outcrops of rotted rock. Finally the principal conditions necessary are the mineralization of the original rock mass; the physical structure thereof; topographic and climatic conditions favorable to the complete degradation and transportation by progressive action of the copper minerals in solution to a lower horizon, there to be precipitated either upon leaner pyrite in the formation of workable bodies of secondary sulphide enrichment, or else, in the absence of primary pyrite, as secondary carbonates and silicates.

GENERAL CHEMICAL PROCESS.

The oxidation of a deposit of sulphide ores is practically the same regardless of the form or character of the deposit. The solution of the sulphides generally is in the nature of sulphates, resulting in the precipitation of the metals at a lower horizon in the form of secondary sulphides. The reduction of the sulphates to metallic sulphides may be accomplished by several different processes, but most frequently by carbonaceous matter, precipitation by hydrogen sulphide, or the reaction of the metallic salts with the unoxidized sulphides below water level; in which event the latter go into solution as sulphates (or other salts), the former precipitating as sulphides.

The first reaction considers that of the oxidation of the original sulphides. Aside from the exposure thereof to the action of atmospheric oxygen and moisture, strong oxidizing agents, such as ferric salts, play an important role. Relative resistance to oxidation and solution is an important contributing factor, and it may happen that chemical action is slower than the physical in which event the partially decomposed original product might be carried away before its contained copper content has been thoroughly leached and carried downward. Further, the chemical and physical composition of the gangue minerals may be such as to make them exclusively the determining factors.

IRON SULPHIDE A FACTOR.

Where pyrite is the predominating sulphide of the original mineralization its products of oxidation are particularly essential as reagents in the enrichment process. There are several ways by which reduction of the pyrite to ferrous sulphate is accomplished: (a), by oxidation solely by atmospheric oxygen, resulting in the formation of ferrous sulphate and free sulphur; (b), reduction to ferrous sulphate, and formation of sulphur dioxide, and (c), a more complete reduction by combined free oxygen and water to the ferrous sulphate and sulphuric acid. In the presence of an excess of sulphuric acid the ferrous sulphate, assisted by free oxygen, results in a further reduction to ferric sulphate. Ferric sulphate, however, is unstable near the surface, but at lower horizons (and assisted by other ferric salts) becomes an active oxidizing solution. Consequently the instability of ferric sulphate near the surface, and the active evaporation attending its presence, results in its forming a product consisting of the various hydrated

oxides of iron. The oxidizing action of ferric sulphate at lower horizons in the presence of water results in its breaking up into two molecules of ferrous sulphate, one of sulphuric acid, and a free atom of oxygen to attack oxidizable substances.

Considering the chemical changes that would take place when copper sulphate comes into contact with iron sulphide, the copper sulphate is reduced to cupric sulphide with the formation of ferric sulphate and the liberation of free sulphur, the ferric sulphate would in turn easily be reduced by hydrogen sulphide or free sulphur. The presence of hydrogen sulphide, resulting from the attack of free sulphuric acid on pyrite would result in the formation of the cuprous sulphide. However, in the direct formation of cuprous sulphide from an assumed solution of copper sulphate it probably would be more reasonable to consider the reactions as obtaining only between copper sulphate, iron sulphide and water; in which event a direct reduction to cuprous sulphide would be brought about with the formation of ferrous sulphate and sulphuric acid with no liberation of free sulphur. The exact chemical reactions governing secondary enrichment will never be written, but some light may be shed on the subject by means of the results obtained in laboratory experiments.

Little attention has been given the subject of the important influence of sphalerite as an active mineral constituent in the chemical reactions governing sulphide enrichment. That it plays a very important role in the case of many of the "porphyries" is well known, but investigations have not been sufficiently thorough to afford much data on the subject.

While thus far we have considered only the relative reactions between metallic sulphides, if we assume the solutions of the original leached area to have been copper bicarbonate instead of copper sulphate results will be obtained wherein the iron will form as a carbonate in lieu of sulphate. However, if the downward percolating solutions carrying copper carbonate do not encounter sulphide precipitants they will not form sulphide deposits at any depth. In consideration of this it will readily be appreciated that the chemical reactions governing the process may be acid, basic, or neutral and as there is no fixed rule in connection with the formation of downward sulphide enrichment deposits other than that above outlined each individual deposit must be considered independently.

Sand Filling As Support Of Mine Workings

By Al H. MARTIN.

The extraction of pillars of rich ore, and permanent support of the old workings, has been a problem for most mine managers from the days of comprehensive lode mining. The most general practice has been the close timbering of heavy ground with expensive timbers, but this has prevented in most instances the subsequent mining of portions of the ground, and compelled the management to abandon numerous pillars of rich quartz, as the timbers have needed the support of the column of rock to sustain the tremendous weight of the hanging-wall. Not only has the adequate support of the underground workings compelled the constant attention of the manager during the active life of the property, but even after the passing of its productive period, because of surface disturbances. The subsidence of the old mine workings has often endangered portions of towns and cities, and legislation has been frequently threatened against the mine owners to prevent trouble of this character.

The finest grade of timber is certain to weaken and collapse under the crushing strain of millions of tons of settling earth in the course of years even when supporting pillars are permitted to carry the greater portion of the strain. In many of the Rand mines, and numerous American properties, it has been found that the ore pillars show decided signs of crushing after carrying the prodigious weight for some years, even with the reinforcement of close sets of timbers. This is particularly marked when the vein-system has a fairly steep dip. Various expedients have been proposed to overcome the problem, and in several instances efforts have been made at its solution by employment of steel timbers, and reinforced concrete supports. Objections to such practices have developed, but the method has generally proved satisfactory when compared with old-time provisions.

It has fittingly remained for the great Rand mining field of the Transvaal to devise and perfect a method at once satisfactory and inexpensive—a method that has so convincingly demonstrated its merit that its use is becoming general throughout the greatest gold field of the world. On the Rand mining is conducted on a stupendous scale hardly appreciated in other fields, and the question of adequately supporting the mine workings at low costs has developed into a vital consideration. Practically all the premier companies have devoted special attention to the subject and after years of systematical experiments sand-filling has been selected as the ideal solution of the vexing question. The employment of the method has been particularly marked during the past two years, and its use is making rapid advances throughout the entire field. The success of the experiment on the Rand has claimed some attention from American operators, but is deserving of a better reception than has been generally extended it on this side of the hemisphere. American mine managers are proverbially slow to adopt the practices developed in foreign fields, which may account for the apparent indifference accorded the method developed by the Transvaal operators.

One of the most successful of the sand-filling plants on the Rand is that operated by the Witwatersrand Deep, Ltd., which has been in commission about eight months. The plant was designed after the method had been thoroughly tried out by several other operators, and embodies all the good features of earlier installations, together with many original improvements of merit. The mill of this company crushes about 38,000 tons of ore per month and 60 per cent of the reduced product is sand, or approximately 22 000 tons. All of this is turned back into the mine for filling of the old stopes and other workings. The Witwatersrand Deep claims are traversed by the great East Rand dike which practically cuts the property into north and south sections. In both portions of the mine sand-filling is proceeding, and not only has it facilitated removal of the rich pillars hitherto employed as supporting agents, but also enables the operators to mine large areas of ground formerly inaccessible under ordinary working conditions. The sand is sent from the surface into the northern portion of the mine through a hole bored for the purpose, and the south section is supplied by way of a winze.

METHODS EMPLOYED ON THE RAND.

At the receiving terminals are placed rows of tanks commanding belt-conveyors. These deliver the product of two

METHOD OF TREATING PAN SLIME.

The author's method in treating this "pan slime," as it was called, was as follows: The first solution applied, about one-third of the weight of slime to be treated, tested from 0.12 per cent to 0.15 per cent KCN. This was percolated upwards till the surface of the sand was covered, and the remainder then run on top. This procedure, proved to be the best method, as it was found that by running the first or strong solution on top, a thin layer of impermeable slime formed on the top of the charge which very considerably retarded percolation. The first solution was allowed to soak for about six hours, and was then drained off. Two or three washes testing from 0.10 to 0.04 per cent KCN, and a final water wash were then run on in rotation and drained off. The practice was to give as many washes as possible, and suction had always to be applied towards the finish for a longer or a shorter period, as the filtering properties of the slime demanded. The total quantity of solution used, was from 70 tons to 80 tons per 100 tons of slime treated.

The amount of mercury which was extracted from this "pan slime" was considerable, as much as from ¾ oz. to 1 oz. per ton being common. This mercury was deposited in the extractor boxes, and materially, and adversely, influenced the quality of the bullion which was obtained. Its effect was to make the whole of the zinc exceedingly brittle so that the contents of the first three or four compartments were amalgamated and formed a zinc sludge, the greater part of which was zinc. This had all to be removed at clean-up, together with a proportionately large amount of short zinc from the other compartments, in order to prevent a continual congestion of the boxes.

The extraction of gold by cyanide was always satisfactory, notwithstanding the presence of the mercury in the material. The average original assay was from 2 dwt. to 3½ dwt. per ton, and the residue assayed from 8 gr. to 21 gr. of gold per ton, as the weather and other conditions of treatment varied. A precaution which was found to be necessary in dealing with the leachings from this class of material, was that the gold bearing solution, before passing into the extractor boxes, had to be freed of any slime which might have been drawn through the filter cloths of the percolators. The most efficient type of settling vat for this purpose, was found to be one constructed after the pattern of an extractor box but of a much greater depth, each compartment being packed with cocoanut fibre to which the fine particles adhered. These were cleaned out at intervals.

In the treatment of the old accumulations as already described, little or no free acidity was found, but on one or two of the mines a large amount of latent acidity was encountered. At Ooregum mine this was found to be cause by the presence of sulphate and chloride of magnesium. These salts were traced back to the water used in the mills and cyanide works, and their action on cyanide is commonly represented by the following equation:

$$MgSO_4 + 2KCN + 2H_2O = MgH_2O_2 + K_2SO_4 + 2HCN.$$

The admixture of caustic soda with the cyanide solutions neutralized the destructive action of the magnesium salts, and it was found merely necessary to add the caustic soda to the cyanide solution instead of being applied as a preliminary alkaline wash. Cheaper alkalies were experimented with, but caustic soda was proved to be the most satisfactory, and its use has now become more general on the Kolar gold field, where the use of alkalies is found to be necessary.

The ore encountered is free milling. The percentage of pyritic concentrate varies on the different mines, but taken as a whole it does not average more than 1½ per cent, and for this reason the sand can be weathered without detriment. The weathering, whilst oxidizing the pyrite, and freeing the gold contents, is further advantageous in freeing the sand of surplus moisture (reducing it from 12 per cent to 16 per cent down to about 3 per cent). This converts it to a more friable state, any slime present can be easily powdered and having no water to displace can be thus easily saturated with solution, and the lixiviation and subsequent washings more thoroughly and quickly carried out. To illustrate this the following large scale experiments are interesting: Some hundreds of tons of sand, taken directly from one of the series of settling pits at Mysore, were dumped separately and allowed to weather thoroughly for about four months, being turned over at intervals, so that the weathering would be as thorough as possible.

(a) A vat was charged with the above sand and put through a 48 hours' treatment in the usual way.

Result: Original assay, 3 dwt. 17 gr., gold per ton; Residue assay, 1 dwt. 2 gr. gold per ton.

(b) Sufficient of the same sand was then charged into a similar vat, after being first saturated with water to about 15 per cent. It was put through a 56 hours' treatment.

Result: Original assay 3 dwt. 17 gr. per ton; Residue assay, 2 dwt. 3 gr. per ton.

(c) To ascertain whether a better extraction could not be obtained from the dry sand, with a longer treatment, another vat was charged with similar weathered sand and treated for 72 hours.

Result: Original assay, 4 dwt. 21 gr. per ton; Residue assay, 2 dwt. 3 gr. per per ton.

(d) A vat was charged with sand taken directly from the sand settling pits as they were being emptied, and given the same treatment as (b).

Result: Original assay, 4 dwt. 0 gr. per ton; Residue assay, 3 dwt. 12 gr. per ton.

The residues from these trials were graded and assayed, and the conclusion arrived at and subsequently acted upon was, that the worst extraction was chiefly due to the slimy lumps. These lumps being impermeable to the solution did not yield their gold content, as they held up their original moisture which could not be replaced by cyanide solution. The treatment of weathered mill sand has been tried in many ways and under all conditions, and it has been clearly proved that if a dry product containing no lumps is charged into the vats, the bulk of the gold contetns can be extracted; but if too much moisture is present the extraction is not satisfactory, as a stage is reached when washes are not effective in liberating the dissolved gold, caking, and channelling of the charge and choking of filter cloths having taken place. An important consideration which affects this question is that for nine months of the year, there is practically no rain-fall, and it is noticed that during the wet weather the extraction in the cyanide works is never so good as after a spell of dry weather.

SOLVING IMPORTANT PROBLEM.

The success of the cyanide process having been once established, the question of the collection and preparation of tailing for future treatment became an important one, and was given more consideration than it had previously received. It was proved that the mill sand before treatment had to be carefully prepared to give good results, and to attain this as rapidly as possible, the wet pulp from the mill settling pits was dumped in two or three separate heaps which were worked off in rotation. The piles to be treated had to be powdered in exactly the same manner as the pan slime. In working through a pile, it was found best to work over its face, and

after exposing a fresh surface, to leave that for a time to the action of the sun, before transporting to the cyanide works for treatment. The grade of these old piles was found to vary considerably, and after a series of experiments it was suggested by the author that a standard screen, from 90 mesh to 110 mesh be adopted for the stamp mills on the field. This was acted on with satisfactory results. As the larger cyanide plants afterwards erected more rapidly overtook the mill production of crushed material, it sometimes happened that the more slimy portion of the tailing was not sufficiently dried, with the consequent decrease in the extraction, owing to the impermeability of the wet slime, as before mentioned.

It was at this time, about twelve years ago, that the author advised the use of collecting vats, fitted with distributors, to replace the existing mill settling pits. Experiments had been tried on a large scale to determine the method of these experiments demonstrated: (1) That it was necessary for successful treatment to have an evenly mixed mass of sand and slime, and (2) it was also an advantage to have this weathered as long as possible before treatment. If these two conditions could be obtained, loss could be prevented and the extraction greatly improved. The introduction of collecting vats and the increasing size of the discharge dumps, necessitated, in a number of instances, the use of power plant to convey the sand to where it would be dumped. The problem to be faced in discharging was to obviate the difficulty of increased height of the dump, which would render later, some hoisting arrangement necessary, and to overcome this, various methods were introduced. In one instance an old pan mill building had to be utilized as part of a cyanide plant installed for the purpose of working off the large accumulation of pan slime with which it was surrounded. This being situated on the lowest lying ground of the property, and adjoining the boundary line, it was for economical reasons necessary to treat the material on the spot. The charging arrangements were ideally simple, but to get over the discharge difficulty a high wooden incline was erected. The height of this from top of the incline to the level of the discharge from the vats was 60 feet. It was provided with four tracks, and four platform trucks worked in pairs, each pair being independent of the other and having its own winding engine. This arrangement proved an expeditious and satisfactory method of discharge. The incline was constructed entirely from useful and common sized battens, in standard lengths bolted together, and these were readily used for other purposes when the accumulated slime had been worked off. In erecting new plants, a common method was to utilize the site in such a manner that the necessary height could be obtained at the charging end, by hauling the sand to be treated up an incline by means of trucks attached to a steel rope, worked by a winding engine.

At the Champion Reef collecting vats, the conveyance of the material from these vats to the cyanide plant was conducted by means of an aerial ropeway. The system adopted was the "Otto," two carrying ropes, and an endless hauling rope, with automatic engaging and disengaging gears, being employed. These vats were emptied through bottom discharge doors, the sand being fed directly into the buckets of the aerial ropeway, which were suspended below the vats on a system of hanging rails. The buckets, when filled, were pushed by hand to the loading station, and there engaged by the automatic loading gear, and carried by means of the hauling and carrying ropes to the unloading station, where they were dumped into the trucks used for conveying the sand to the dumps from which the cyanide plant was charged. This ropeway has been working since 1902. It conveys the sand to be treated, a distance of about 200 yards to a height of 90 feet, or about 25 feet above the level of the percolation vats.

THE MYSORE PLANT.

The largest sand handling plant on the Kolar gold field, has been erected at the Mysore mine. The collecting vats of this plant are discharged by means of bottom discharge doors on to belt conveyors, which elevate the sand a height of about 40 feet above the level of the charging tram roads of the cyanide works, or to a total height of about 72 feet. These belts were at first arranged to work off one engine, the driving shaft being provided with a separate clutch for each belt (the belts running parallel, and each being in one piece). These belts had each a length of about 500 feet from the center of the terminal tightening pulley, to the center of the terminal discharge pulley, but it was found from experience gained, that the working could be facilitated, and the wear and tear minimized, by substituting two shorter belts in place of the one longer belt. The sand is charged on to a horizontal belt running the whole length of the collecting vats, and this in turn is discharged on to an incline belt. The sand on reaching the top of the incline, is discharged into a hopper from which trucks are filled and pushed by hand to the edge of the dump in course of preparation. The dumping station, and incline carrying the belts, were made of steel trellis work, the lower half of which was filled up with waste material that did not require to be removed. A great difficulty was at first experienced in getting the feed of the belts from the collecting vats properly adjusted. This was, however, overcome by means of a straight sided hopper, hung below the discharge door. This, in turn, fed on to a wide shallow hopper, about 4 feet long by 3 feet wide, provided with a discharge opening, or chute, the full length of the hopper and running in the same direction as the belt. This chute was about 3 inches to 4 inches in width and the sides, finished off with rubber insertion, were just long enough to clear the moving belt. To prevent the sand from falling directly on to the belt and choking, and also as a safeguard should any of the workers' tools fall through the discharge door, a protecting length of angle iron (4 inches or 5 inches) was fixed above the belt and directly over the feed chute, the angle pointing upwards. By this means, and with the assistance of a man with a small hand shovel, the feed could be kept even, and overloading the belt rendered impossible.

The sand from the collecting vats is stacked so that it may have as much drying and weathering as possible before treatment. It consists of an even product, free from slimy lumps, but having a fair proportion of slime evenly distributed through its mass. The necessary drying is obtained by building up piles in rotation, and working off the oldest in the same manner as that used before the installation of collecting vats, except that with it no lumps have to be broken up, as the slime present is intimately mixed with the coarser sand. In this case, however, prolonged sun-drying is unnecessary, as the sand is freed from excess moisture while still in the collecting vats. The Mysore mine, on which the above mentioned plant was installed, has three stamp mills, with 120, 60 and 30 heads of stamps respectively, and the tailing therefrom was treated in three widely separated cyanide plants, two of which had been erected originally to treat dumps of the old pan tailing, and the other for the output from the 120 head mill when it was erected. This division of the works could not be called satisfactory, and as it became essential to introduce some more suitable method of collecting the sand, to replace the old settling pits originally laid down, the author designed a system for centralizing the sand settling arrangements, so that the whole output from the three

mills could be treated in one cyanide plant as follows: The pulp from the three mills is carried in launders of 12 vats, each 30 feet by 6 feet deep. These are discharged on to the two conveyor belts already mentioned (one belt for each line of six vats), which in turn convey the sand to the dumps for treatment in the cyanide plant. The collecting vats are provided with sand filter bottoms (filtering cloth of various materials was tried but discarded, as the cloth rotted too quickly). When a vat is full, a drain cock is opened, and as much water as possible drained off by gravity. Vacuum is then applied for a few hours and the sand is then ready for discharge. About four hours is required to empty one of the above vats, the usual time taken for draining and empting a vat occupying about ten hours.

The cyanide plant in which this material is treated was originally laid down for the 120 stamp mill only, and it at first consisted of nine percolators, each 30 ft. x 6 ft. deep. These vats were charged from the west side, but when the central treatment system, by which all the tailing was to be treated in this plant, was installed, it became necessary to increase their number, and to charge them from the north end. The first increase was effected by the addition of three more vats of the same capacity as the others. Improvements having however been effected in the stamp battery crushing, a corresponding increase in the cyanide plant was required. To meet this, four more vats of 36 ft. dia. were laid down, and latterly the nine original vats were replaced by vats of a greater capacity.

Much the same treatment is given to the sand from the collecting vats, as was the practice in treating the mill tailing dumps before their introduction. The first, or strong solution, testing from 0.13 per cent to 0.16 per cent, is either run on top or percolated upwards and allowed to soak for six hours or so. It is then drained off, and as soon as the solution disappears below the surface of the sand, a so-called solution wash, testing from 0.1 per cent to 0.13 per cent, is applied. Then follow about five weak washes from 0.08 per cent to 0.05 per cent strength and a final water wash. Vacuum is applied at the end of the treatment, to ensure the discharged sand being as dry as possible. It was customary in the earlier days to use a higher percentage strength of cyanide for the first solution, but by experience this was found to be unnecessary, and simply increased the consumption of cyanide without a better result being obtained.

The extractor boxes used, and still in use to the present day, are nearly all of the central launder type. This type, which the author designed for the Cassel company has proved in his experience, to be quite as efficient as any of the side launder types, and easier for the operator to clean-up. It is also more compact, and easier to keep under lock and key, where this is necessary. The ordinary clean-up arrangements in connection with the reduction of the gold slime obtained from the old pan mill tailing varied according to the ideas of the chemist in charge. The general plan involved discharging the finer contents of each compartment, through the launders, to a vacuum filter box, sieving to remove coarse zinc which was returned to the extractors, treating with acid, smelting, and finally melting the buttons into bars. The roasting of the gold slime was a very important point, affecting the subsequent purity of the bullion, and the author's experience was that the trays, after being charged, should be left untouched until their contents are nearly all oxidized; this usually took from half to three-quarters of an hour. By this means dusting, the great drawback to this operation, was practically avoided, but if the trays were disturbed at this stage, dusting always resulted. The heat was always carefully regulated to prevent volatilization.

The retorts necessary for the recovery of the mercury obtained from the pan mill slime were cylindrical, each being provided with one long movable tray and fitted with covers that could be locked. The usual form of Liebig's condensers were used for condensing the mercury. The roasting furnaces were in batteries of from three to ten, and consisted of cast iron trays hooded over with brick. They were fired from below, and the fumes and combuston gases were carried each by a separate flue to a large main flue, which could be cleaned out when necessary.

The smelting furnaces were arranged for forced draught, and each consisted of a rectangular fire-box, large enough to hold two No. 80 Salamander crucibles. Into the bottom of this fire-box the air for the combuston of the coke used was forced by means of a jet of steam or compressed air. A charge usually took about forty minutes to run down. To recover the gold contained in the slag from smelting operations, ash, clinkers, crucible scrapings, sweepings from floors, etc., the author many years ago introduced as part of the cyanide clean-up process, an amalgamation pan through which every such by-product likely to contain gold is passed. Everything which has to be treated in the pan, is first ground in a ball mill to one-eighth mesh, and then reground with mercury in the pan. Each charge receives about three hours grinding, after which it is discharged over riffles, and collected in a settling vat. What is caught in the riffles is put back into the pan for further grinding, and the contents of the settling vat are stored. The amalgamation pan is cleaned up as required and the recovered amalgam retorted, the resulting sponge being added to the next month's bullion at melting. The tailing from this process is rich, and when sufficient has been accumulated it is treated by cyanide, which usually yields an extraction of about 90 per cent of the gold contents. The gold slime from the mill tailing is not as a rule retorted, as the mercury would scarcely pay for retorting. In roasting this class of product, however, it was always left untouched till all mercury had been volatilized, and when this condition was properly observed, the loss due to dusting was reduced to a minimum. The above brief description of the clean up is a summary of the general practice on the Kolar gold field till some years ago, but it has since been considerably modified, by several improvements in zinc box practice introduced by the author, which have been in successful operation for a number of years.

PRECIPITATION IN THE EXTRACTOR BOXES.

With regard to the precipitation of the gold on the zinc, the original practices was, to use one-half of the extractor box capacity for strong solutions, and the other half for weak solutions. It was noticeable, however, in this that the weak boxes invariably contained as much slime at clean-up as the strong boxes, but that it was not so rich in gold. To get a more even product, about eleven years ago the alternate use of the boxes was tried, those getting the strong solution one day, getting the weak the next, and vice-versa. This proved a decided success, the resulting slime at clean-up being more uniform, and the precipitation equally as effective as before.

It was further noticed, that when at any time the tonnage of a plant was reduced, thus giving less gold to precipitate, the bulk of the slime from the extractor boxes remained much the same, without any improvement in the precipitation being noticeable. This pointed to the possibility that the excess of zinc was more a disadvantage than otherwise. In other words, this excess of zinc acted as what might be called a chemical filter, and precipitated other compounds in the extractor boxes. This was prob-

ably due to the subsidiary re-actions set up between the zinc, cyanide, and alkali plus atmospheric oxygen, and the result, taken from a reduction point of view, was undesirable.

Working on this basis, the author started to reduce the amount of zinc in the boxes, and after trials at the Mysore mine lasting over two years, it was found that from the solution used in treating 10,000 tons of tailing per month, as good precipitation could be obtained by using thirty-seven cubic feet of space occupied by zinc shavings, as was obtained from the ninety-seven cubic feet previously considered necessary. This resulted in a great saving of time and materials, and instead of four full extractors to clean-up, two partly full were found to be sufficient, at the same time the quality of the slime was greatly improved, and the quantity to be handled much less than it had ever been before. The fineness of the bullion also increased in much the same proportion, varying from 860 to 910 fine gold, with from 45 to 65 of silver per 1,000 parts.

The following table showing results from one set of vats under treatment, is characteristic of what is to be expected with the reduced zinc precipitating surface.

There are a few important points that must be observed in connection with this reduction of zinc precipitation surface. The extractors used must be perfectly solution tight so that no one compartment can leak into another, otherwise the precipitation will be imperfect. The boxes should also be packed with clean

Vats Nos. 7 and 8		Before Extractors			After Extractor	
Sample	Interval	Strength of solution	Assay per Ton Solution		Assay per Ton Solution	
		per cent.	dwt.	gr.	dwt.	gr.
1st	5 hours	0.105	0	13	0	3
2nd	"	0.040	1	13	0	3
3rd	"	0.040	4	11	0	7
4th	"	0.045	4	17	0	3
5th	"	0.060	4	7	0	2
6th	"	0.070	3	14	0	5
7th	"	0.070	2	15	0	3
8th	"	0.050	2	2	0	3
9th	"	0.050	0	23	0	3

shaving (the thinner the better, as coarse zinc gives very poor results), fresh from the lathe, and if this cannot be obtained, the dust and short zinc should be got rid of as much as possible before packing. The packing should be done firmly and with as little tearing as possible. The rate of flow of solution through the boxes can be as fast as possible without overflowing the compartment, when these boxes have a fall of one to twelve. Two extractors should be all that is necessary for any gold ore treatment plant, provided they are designed properly. Each should have four or five compartments for containing zinc shaving, with two or so left vacant for emergency at either end. The precipitating space should be about 0.4 cubic feet per 100 tons of the monthly tonnage treated, and the compartments should be provided with plenty of space below the trays. The boxes should be used day about, or changed at shorter periods for strong and weak solutions. The zinc should be prevented from floating up, and choking must be avoided; a convenient arrangement being the use of ¼-inch mesh trays laid on top of each compartment, and so fixed that the contents are prevented from rising above the same. They should receive regular and daily attention, and be cleaned up once a month, or oftener if necessary. The presence of much silver in the solution makes the precipitate much bulkier, and if required the spare compartments can be brought into use. The quantity of zinc used per ton of sand treated, averages from 0.06 pounds to 0.08 pounds.

Instead of the simple filter box at the end of the extractor for filtering the gold slime at clean-up, a steam jacketed filter box is used. This does away with the double handling necessary for the drying of the slime before smelting when the steam jacketed filter box is not used. The procedure at clean-up is as follows: The boxes are cleaner in the ordinary way, the gold slime being washed into these filters by means of the central launder in the extractor box. After the excess moisture has been drawn off by means of vacuum, steam is turned into the steam jacket and the slime is thus quickly dried to the point which by practice is found best. It is customary to leave enough moisture in the slime to prevent dusting during handling, and when it is being mixed with the fluxes preparatory to smelting. The slime is then conveyed to the smelting room, and mixed with manganese dioxide, borax glass (ground) and sand. This mixture is charged into Salamander crucibles and converted to bullion in the usual way.

The following table shows the cost of smelting slime from which bullion weighing 1,673 ounces was obtained, the fineness being 870 fine gold:

	Pence per Ounce Fine Gold.
Borax	.32
Manganese	.11
Coke	.94
Crucibles	.79
Steam	.09
Native Labour	.04
Soda	.00
Supervision	.33
	2.62

The cyanide works on the mines were directly under the charge of a chief cyanide chemist, who had one or more assistants as required. All testing of solutions, assaying, cleaning-up, and supervision was done by them. Each plant had three foremen (with sometimes one extra as well), whose duties consisted in the carrying out of the treatment, as directed by the cyanide chemist. The native labour employed consisted of three firemen, where steam power was used, three engine drivers (or motor drivers as the case might be,) who attended to the engine or motor, lathe, pumps, shafting, etc., and in addition two or three spare coolies were employed whose duties were to keep the works clean. The natives' pay varied from 8d. to 6d. per day of eight hours. The charging and discharging was done by native contract. The cost of both together averaged from 3¾d. to 4½d. per ton of dry sand treated.

The consistent economic improvement in the working of the process on the Mysore mine, may be gauged by comparison of the working costs, as the following figures will show:

The foregoing outlines what has already been accomplished, but further developments in the application of the cyanide process may be looked for. For some years prior to his retirement the

Year.	Tonnage.		Total Costs. As Published.			Cost per Ton.	
	Long Tons.	Short Tons.	£	s.	d.	Long Tons. Pence.	Short Tons. Pence.
1902	114,459	128,294	11,476	4	9	24.04	21.46
1903	126,646	141,843	11,313	6	11	21.43	19.14
1904	Not available at time of writing.						
1905	165,491	185,349	11,947	9	2	17.32	15.47
1906	158,848	177,909	10,854	18	2	16.40	14.64
1907	167,529	187,632	11,588	14	8	16.60	14.82
1908	184,643	206,806	12,060	2	7	15.68	14.00
1909	190,388	213,234	12,581	4	3	15.85	14.16
1910	195,530	213,393	12,321	9	10	15.52	13.85

author realized that by means of tube milling better and more satisfactory results would be obtained. He also emphasized that the question to be decided with low-grade slime was dependent on the efficiency of the slime plant to be installed, and that this question would become more prominent with the introduction of tube mills when the percentage of slime would be increased, as the benefit to be derived from their introduction would be so largely dependent on the profits obtained from the treatment of the slime.

Although no mention had been made of some of the more modern methods of treating tailing, these have received very careful attention. The question of classification and regrinding of years one on which for a number of years much time has been expended by the metallurgical staff at Kolar, and numerous experiments have been carried out and a large amount of practical work accomplished in this direction. The author as consulting metallurgical engineer had charge of a central laboratory during his last six years in India and conducted a large number of working scale tests on these points and also in connection with the treatment of slime. These included experiments with most of the modern types of filters. Since then tube mills and filter plants have been introduced and he is of opinion that it is only a question of time when their use on a large scale will be adopted on all the mines on the Kolar field.

AN OUTLINE OF MINE ACCOUNTING

By HENRY B. FERNALD.*

The difficulty in writing of mine accounts comes from the fact that each mine has its own peculiarities, problems and methods. The varying conditions of operation and organization will naturally call for corresponding differences in forms of cost sheets, divisions of accounts, timekeeping methods, storehouse accounts, etc. There is, therefore, no fixed standard by which mine accounts should be judged since each mine should have the accounts and records which will present with accuracy, clearness and economy the facts regarding its operation and financial condition.

But in spite of the multitude of varying details to be considered in each case, there is a general scheme of accounts which must apply to every mine in accord with the very nature of the mining business. If its general outline can be kept clearly in mind, the questions regarding details are much more readily settled, and more satisfactory operating and financial statements will result. It also gives a common ground for the operating and accounting departments to meet, without requiring the one to consider bookkeeping details nor the other to pass upon engineering matters.

The outline as here presented will not, therefore, attempt to recommend special bookkeeping methods nor to decide engineering propositions. We should know the cost of mining irrespective of whether it is surface or underground. This must include development costs, either as the expenditures are incurred, or proportionately to the tonnage of ore extracted. All the accounts may be kept at the mine or they may be divided between the mine and the home office.

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ESSENTIALS OF MINE ACCOUNTING

But whatever is done along these and other lines, the essential facts stand out that, having at hand the mining property:

Expenses are incurred as labor, supplies and sundry charges, for operation, equipment or development.

The result of all expenditures is the tonnage of ore, of a certain metallic content, which is mined and is marketed (either before or after treatment.)

This yields a profit or a loss on the mining operations, which, together with the result of rentals, and any other miscellaneous transactions of the company, will be its net profit or loss. A profit may be distributed to stockholders as a dividend, may be held as current working capital, or may be expended for equipment, development, etc.

The financial condition of the company at any time is shown by the statement of its resources and its liabilities. The resources may be the current working capital of the mine, the deferred charges to be made against its subsequent operations, and the fixed investment in property, equipment, etc. The liabilities may be for current or for bonded indebtedness.

This statement of resources and liabilities does not, however, take note of the most important factor in determining the value of the mine, i. e., the value of the ore remaining in the mine. The current assets, such as cash, accounts receivable, inventories, etc., are usually to be considered as worth their face value. The liabilities should, of course, be paid in full. But the accounts for property, equipment and development can only represent the expenditures which have been made therefor—the question of value being dependent almost entirely upon the more or less uncertain problem of future ore supply.

This is the situation common to every mine, and is the common ground which all mine accounts must cover. The accounts must, therefore, lead to four statements or groups of statements:

I—Costs.

II—Production.

III—Profit and loss (and surplus.)

IV—Assets and liabilities

The series of outlines which follows is planned to show the general scope of each and their relations each to the others, understanding that the various details of these statements and the forms for their presentation must be a matter for separate determination in each case.

THE MAKE-UP AND DISTRIBUTION OF COSTS.

For conveniences of phrasing, we will consider the current costs as being primarily incurred for:

Labor—As shown by the pay roll and time-keeper's records.

Materials—As shown by the storehouse records.

Sundry expenses—To include the numerous items, which are neither labor nor materials, as shown by the records of the general office.

The records in each case should show how these apply as:

Direct costs of operation.

Direct cost of improvements, construction and other capital accounts.

Distributing accounts (where the labor, materials, etc, do not apply, as such, directly to operation or capital accounts, but require an intermediate grouping, such as power, etc., which is in turn to be distributed to the various operating or capital accounts.)

The total current cost for each division of operating or capital accounts will accordingly be the direct cost, plus the proportion of the distributing accounts which apply thereto. The "current costs" which thus result will not take into account the items of depreciation and of deferred charges.

Whatever may be the basis for charging depreciation, as determined from the engineering standpoint, we must in some way or other make a charge to operation which will, on a proper basis, cover the loss in value of equipment, construction, etc., as operations proceed. Therefore, instead of charging to operation the current costs of construction, equipment, etc., these would be charges to the proper capital accounts; operation being chargeable with the depreciation applying to

the current period, which might be more or less than the current construction or equipment costs

The matter of deferred charges is probably the most difficult question in mine accounting. Briefly, it is the question of what operating costs are to be stated against future as distinguished from current product. It is manifest that the cost of mining and transportation for ore on hand in the mill bins at the end of the month is not properly a part of the cost of the mill product for that month, but is a charge which should be deferred until it can be stated as a part of the cost of the product resulting from that ore. It is also a fairer measure of cost to apply the cost of stripping proportionately to the tonnage made available than to charge against current production the stripping done during that period. These, and other more difficult features, are primarily engineering questions, the answers to which must come from the facts in the case, rather than from accounting methods.

What the accounts should show clearly and definitely is the amount of expenditures for capital accounts or deferred charges, the amounts charged against operations and the basis on which the charges have been made.

WHAT OPERATING COSTS SHOULD SHOW.

A summary of operating costs may therefore be shown as follows:

Direct charges to operating accounts for labor, materials and sundry expenses;

Add charges for the proportion of distributing accounts which apply to current operation;

Giving the total current operating costs;

Add depreciation;

Add previous deferred charges applying to current production;

Deduct any current costs which are to be deferred charges against future production;

Gives total cost chargeable against current production.

The corresponding summary for capital accounts would be:

Balance of capital accounts at the first of the period;

Add current charges to capital accounts (being the direct charges for labor, materials and sundry expenses, plus the proportionate charges from distributing accounts, if any);

Deduct depreciation chargeable to operating accounts;

Gives balance of capital accounts at the end of the period.

A summary of deferred charges would be along the same lines.

PRODUCTION RECORDS.

The details of production records will be determined almost entirely by the character of the ore and its treatment, and the manner of its sale. They should be such as will clearly follow the movement of the product from the ore mined to the ore, concentrates or metals sold, giving all the important information from stage to stage. Although the ledger accounts only take up the facts which can be expressed in dollars and cents, there is such a close relation between the metallurgical data and the final value of the product as to form a single, continuous set of records to correspond to the progress of the ore.

At first the ore simply stands in the accounts as representing its cost to the stage it has reached. Finally, however, it reaches the point where it is to be taken into the accounts at the value of its metallic content which is in marketable shape. The distinction must be made between the gross value of the metallic content, the amount of metal which will be paid for, and the net amount to be received after deducting the charges for treatment, transportation, etc.

Although the general law is that profit can only be considered as earned when an actual sale is made, it is customary in mine accounts to consider the profits when the product reaches its marketable form, as ore, concentrates or bullion ready for shipment. The advantage of having the clear statement of what the mine is doing more than balance the comparatively slight variations which will result from the use of mine assays and estimated marketing expenses.

SUMMARY OF THE PRODUCTION RECORDS.

The summary of production, on this basis, would be as follows:

Gross value of production;

Less smelter deductions, treatment and freight;

Gives net settlement value of production.

If, as is usually the case, part of this production is on hand, in transit or at smelters and not yet paid for, there would also be a summary to show;

Production for the period;

Product on hand, in transit and at smelters at the first of the period;

Giving total production to be accounted for;

Less production settled for during the period;

Leaves the product on hand, in transit and at smelters at the end of the period (which would agree with the total of the individual lots of unmarketed product).

PROFIT AND LOSS.

While one purpose of the cost and production records has been to show from an operating standpoint the costs per ton, foot, yard, etc., and the recoveries from ores, these same records should lead to the balancing of production against cost, to show the profit. It will be recognized that this is practically nothing more than a grouping of the summaries previously given.

The profit is not the difference between the cash received from production sold and the cash disbursed in payment of bills.

As already pointed out, consideration must be given on the one hand to the production not yet settled for, and on the other hand, not merely to the distinction between cash paid out and expenses incurred, but also to the questions of capital and deferred charges and the cost which is properly chargeable against current production.

In addition to the profit from mining operations, there will usually be certain miscellaneous items such as rentals, store sales, etc. Although these may sometimes be of such importance to require a complete set of accounting records for each, such accounts will merely follow the ordinary commercial methods, showing the resulting profit or loss.

SUMMARY OF PROFIT AND LOSS ACCOUNT.

The summary of profit and loss may accordingly give:

Gross value of production.

Less cost of production.

Less smelter deductions, treatment and freight

Giving mining profit and loss.

Add or deduct miscellaneous profits or losses.

Giving net profit or loss for the period.

Add the balance of profits at the beginning of the period.

Deduct dividends paid.

Gives the balance of profits remaining at the end of the period.

ASSETS AND LIABILITIES.

The general divisions of assets and liabilities have already been referred to. Under the divisions will appear such accounts as the conditions in each case may call for. The exact title to be used for each account is of comparatively little importance, so long as it signifies clearly the nature and scope of the account, and so long as the accounts are so carried that the value of each and its relations to other accounts will be readily apparent.

In addition to the accounts for actual indebtedness which will appear on the liability side of a financial statement, there will also be the accounts for reserves, capital stock and surplus. Re-

serves do not represent actual present indebtedness, but stand on the liability side of the statement to represent a reduction in the net value of the assets to allow for indebtedness which will have to be paid at some future date or for assets which must sooner or later be replaced or written off. Capital stock appears on the liability side to show what the business should return to the stockholders to make good the par value of their stock.

If the total assets exceed the total indebtedness, reserves and capital stock, this excess will be a surplus appearing upon the liability side to balance the account. A deficit will be the necessary figure to balance on the asset side.

A brief statement of the relations which increases and decreases in the various accounts bear to one another, may be of value. For example: An increase in the working capital of the mine can be obtained by increasing the indebtedness, by selling stock, by earning profits or by liquidating other assets. Similarly, borrowed money may be used for paying other liabilities, for increasing current, deferred or fixed assets, or may be paid out for expenses.

In considering any statement of assets and liabilities, it should, therefore, be remembered that:

An asset increased means either
- Income earned;
- A liability incurred;
- Another asset decreased.

A liability increased means either
- An expense incurred;
- An asset increased;
- Another liability decreased.

Income earned means either
- An asset increased;
- A liability decreased.

An expense incurred means either
- An asset decreased;
- A liability increased.

It is accordingly evident that any increases or decreases of assets and liabilities which do not affect other asset and liability accounts, must apply to accounts for income and expense. This gives one of the best methods of guarding against errors in the accounts, such as are almost sure to occur if the volume of business is large. A careful checking of the balances of these various accounts to see that they agree with the actual facts which they are supposed to represent will often show items improperly omitted or improperly included in preparing the statements of income and expense.

A statement of assets and liabilities will present in general outline, the following facts:

ASSETS

Current Assets:
Representing cash, accounts receivable, product not yet paid for, inventories and such other assets as constitute the current working capital of the mine.

Deferred Charges:
Representing operating expenses to be charged against future, as distinguished from present, production.

Fixed Assets:
Representing the net investment in property, construction and equipment (the property being carried on the basis of its cost and not at the value of its future production).
Making the total assets of the company.

LIABILITIES

Current Liabilities:
Representing the current indebtedness outstanding.

Fixed Liabilities:
Representing bonded or mortgage indebtedness not requiring immediate payment.

Reserves:
Representing an allowance made for future indebtedness or for the replacement or writing off of assets.
Making the total liabilities and reserves outstanding against the assets.

Capital Stock:
Representing the par value of the full-paid capital stock outstanding.

Surplus:
Representing the difference between the total assets and the total liabilities, reserves and capital stock. (The surplus must also represent the net results of profits from operation, or from other sources, less the dividend disbursements.)
Making a total on the liability side to equal the total of the assets.

In concluding such an outline, it may not be amiss to mention a few matters essential to a clear, consistent set of accounts and records:

RESUME OF MINE-ACCOUNT RECORDS.

(1) The original records should give the information on which all subsequent entries are to be based. Whatever divisions are to be made in the accounts should be considered in the original records. It is much easier to summarize items to get a total than to analyze an amount to obtain its details.

(2) The records should be so planned that the original entries can readily be referred to. Even the outside records kept in pencil can be arranged for proper files or binders. Each record should show clearly where its entries come from and any other records to which they go. Care in planning the records so that they will run in proper series will avoid a duplication of work and will make it much easier to trace individual items throughout the accounts.

(3) A clear and correct statement of the facts is the main object of the accounts. Undue formalities are neither necessary nor desirable. It is often better to make a clear record in statement form, rather than a debit and credit account. The order in which facts and figures would naturally and logically be entered in the original record is usually the best to follow. There must be a certain amount of formal bookkeeping to give a ready proof that every item is fully accounted for, but this should summarize rather than duplicate the various operating statements.

There are many other features of the accounts which might be discussed at length, but the purpose of the above has been to present such an outline as might enable the operating men on the one side and the office men on the other to have a clearer conception of the general nature and meaning of accounting statements.

If the accounting force realizes clearly just what the various accounts and statements are intended to show, much cleaner and more accurate records will result. If the operating men can count on promptly receiving correct statements showing the facts with which they have to deal, presented in a manner which they can readily understand, there will be a practical value in the accounts far beyond their mere proof of the honesty of the employees and the amounts owing to or by the company.

Finally, the best test of a system of accounting is whether it gives promptly, clearly and simply the desired information with not unnecessary loss of time or labor in keeping the records, or making up statements therefrom.

The foregoing article is reproduced particularly for the reason that its author comes from the house of Suffern & Son, New York, special auditors to the Utah Copper Company. As the reader will have noted, the subject is an important one and is well handled. The thing that will appeal to many of the readers of Mines and Methods is, that while this firm knows precisely how to elucidate a corporation status, they evidently are not averse to giving their patrons what they want; because, if there ever was in this world an incomprehensible compilation of utterly valueless figures, they are to be found in Suffern & Son's auditors' presentation of the affairs of the Utah Copper Company.

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Pumps often give trouble because of an unequal pressure within the steam-chest acting on the area of the steam valve or the valve stem. As the valve stem extends through only one side of the steam chest there is a constant tendency to blow it out. To overcome this trouble the use of a coil spring between the bracket and collar has been recommended. This spring should be given sufficient tension to counter balance the action of the steam acting on the area of the valve stem. While the action of the steam is to force the valve stem out of the chest, the spring forces it in again and therefore the forces are neutralized and the valve stem stays where it is left by the tappet arm.

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Mining and Scientific Press on "Recent Problems in Copper Production."

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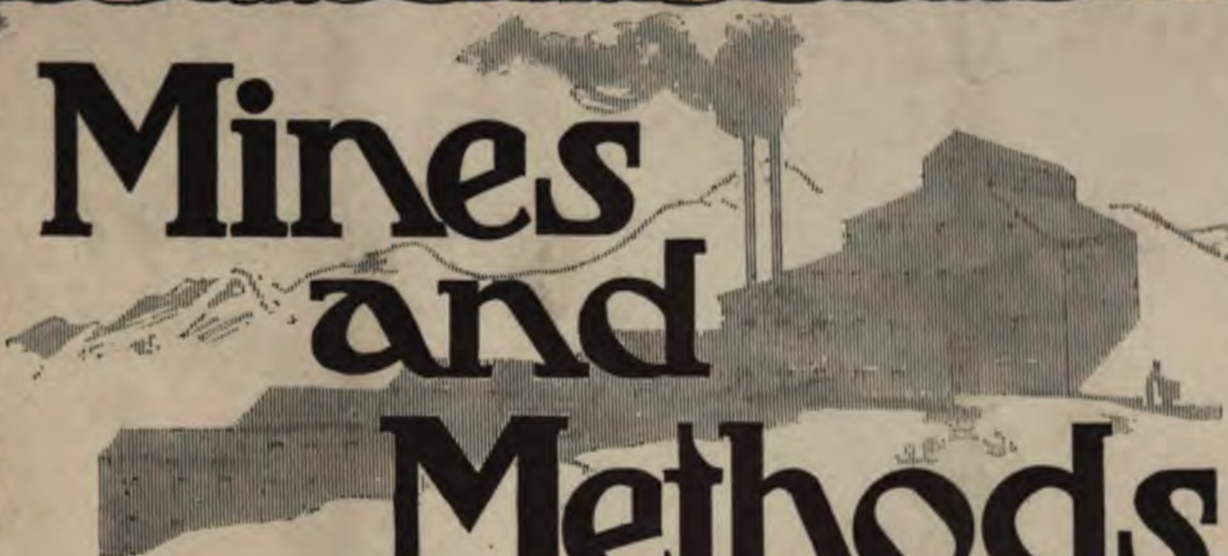

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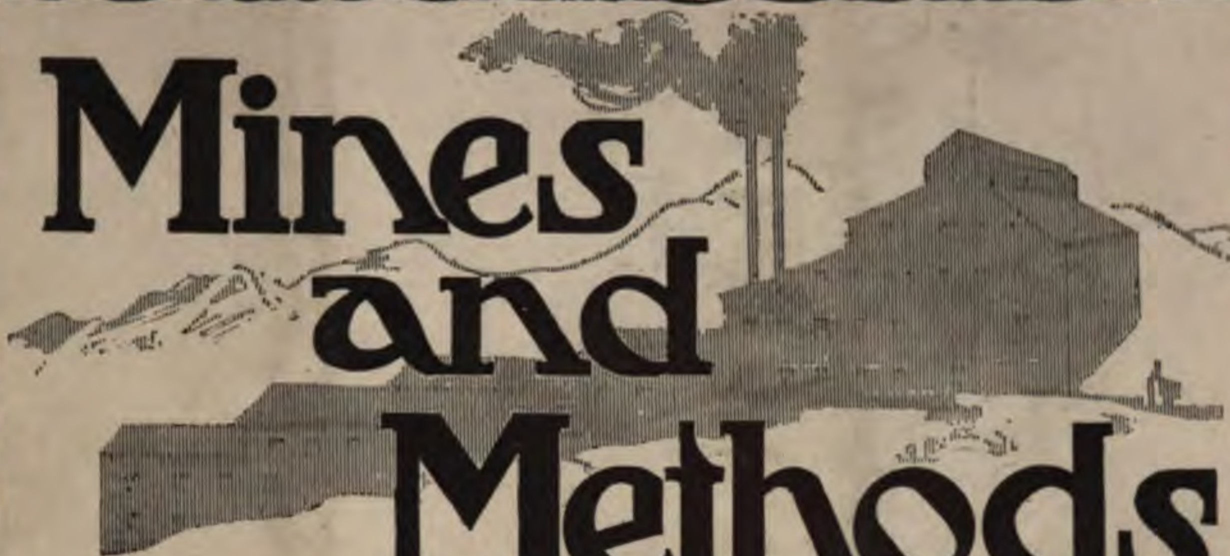

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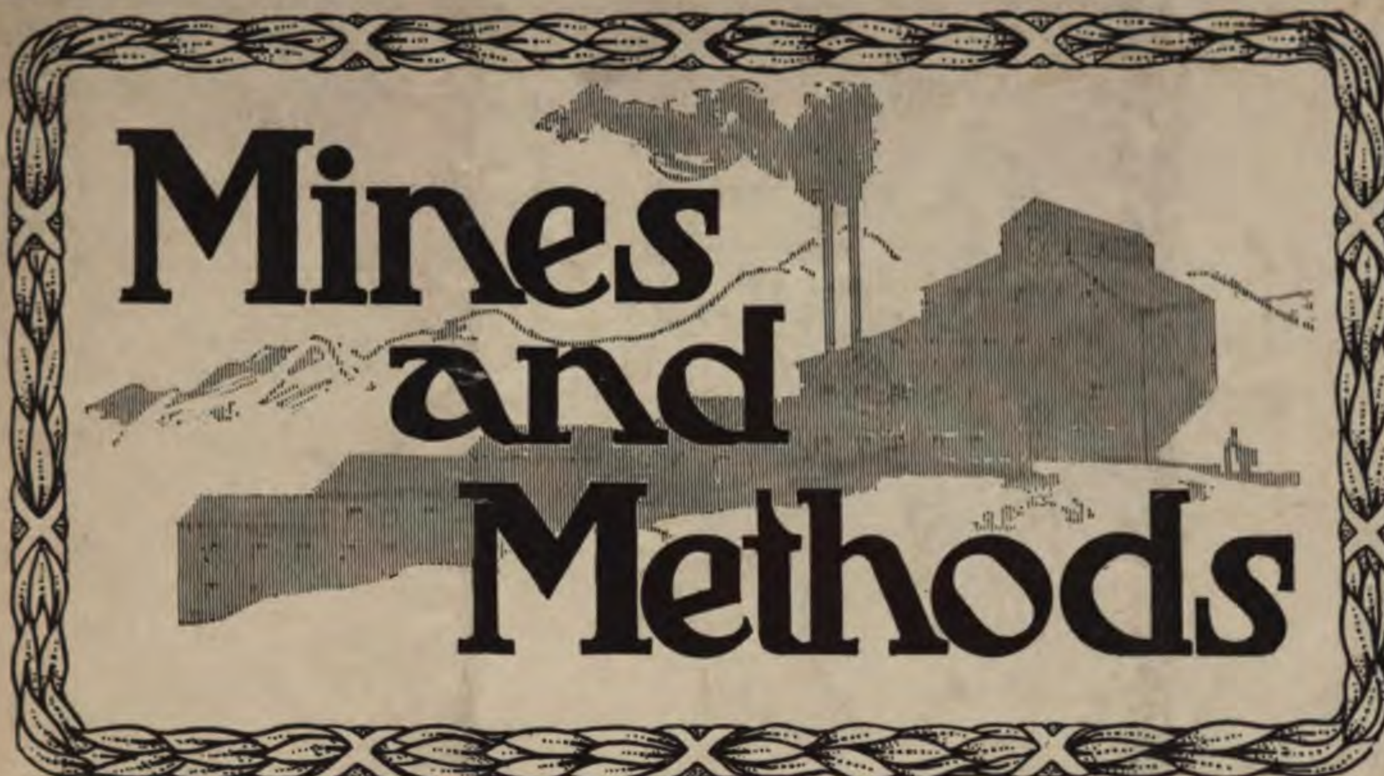

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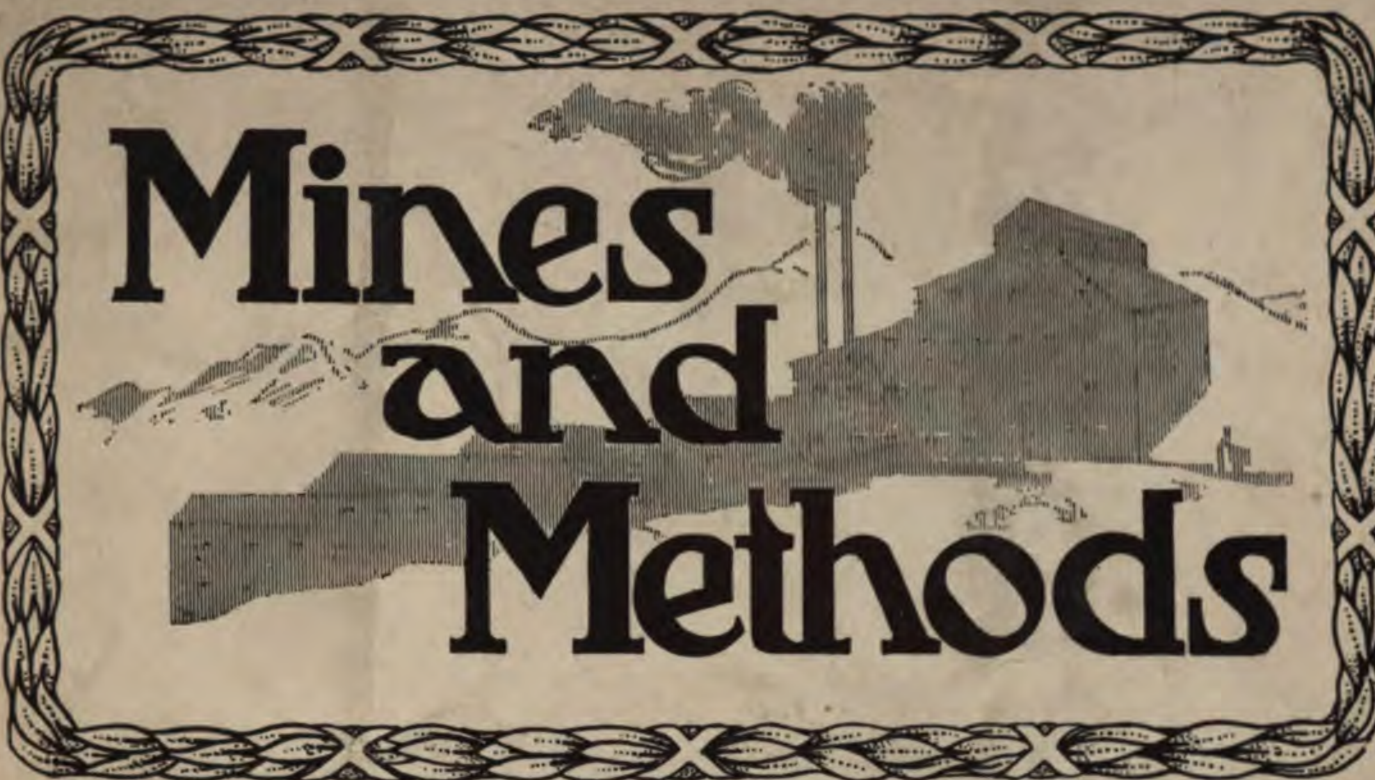

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